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II. Echinoidea (I)

by

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Introduction.

The Echinid-Fauna of the Gulf of Siam has not hitherto been especially treated, and only a few species have been stated to occur there. In „Revision of Echini“ only the following regular Echini are mentioned from Siam: *Temnopleurus torenmaticus*, *Salmacis rarispina* and *Heterocentrotus mamillatus*. In the present work 16 species of regular Echini are recorded from the Gulf of Siam, and of these 4 are new to science, viz. *Chætodiadema granulatum*, *Pleurechinus Döderleini*, *Pl. siamensis* and *Gymnechinus pulchellus*, the first named being the type of a new genus. Of the 16 species mentioned two have not been taken by the author; one, *Temnopleurus Reevesii* was found in the Museum of Copenhagen, labelled Salmin, Gulf of Siam; another, *Echinothrix calamaris*, was taken by the „Skeat“-Expedition on the Malacca-Coast of the Gulf. The species are the following:

1. *Stephanocidaris bispinosa* (Lamk.).
2. *Diadema saxatile* (L.).
3. *Astropyga radiata* Gray.
4. *Chætodiadema granulatum* Mrtsn.
5. *Echinothrix calamaris* A. Ag.
6. *Temnopleurus torenmaticus* (Klein.)
7. — *Reevesii* (Gray).
8. *Salmacis bicolor*, var. *rarispina* (Agass.).
9. — *virgulata* Agass.
10. — *sphæroides* (L.).
11. — *dussumieri* Agass.
12. *Pleurechinus Döderleini* n. sp.
13. — *siamensis* n. sp.
14. *Gymnechinus pulchellus* n. sp.
15. *Toxopneustes piteolus* (Lamk.).
16. *Parasalenia gratiosa* A. Ag.

There can be no doubt that several more species of regular Echini will be found to occur in the Gulf of Siam. The eastern side of the Gulf, to which my researches were confined, is evidently less rich than the western side; and also the median, deeper part of the Gulf doubtless will prove to be inhabited by several species which are not found at the coasts. Upon the whole the Echinid-Fauna of the Gulf will scarcely differ to any extent from the common Indian littoral Fauna. Scarcely any species peculiar to the Gulf will be found; the new species described here cannot be maintained to be so. *Chaetodiadema granulatum* has been taken by the „Siboga“-Expedition, and I have seen specimens from the sea between New Guinea and Australia and from the Maldive-Islands. *Pleurechinus Döderleini* also occurs at Samoa, and *Pleurech. siamensis* has been taken in considerable numbers by the „Siboga“-Expedition. *Gymnechinus pulchellus* is as yet only known with certainty from the Gulf of Siam and Singapore. It seems very probable that all these species will prove to be widely distributed over the Indo-Pacific Region.

Since the *Diadematidae* and *Temnopleuridae* are so well represented in this collection, I have taken the occasion to study these two families more completely, in the same manner as I have done in my work on the „Ingolf“-Echinoidea I. with the families *Cidaridae*, *Echinothuridae*, *Echinidae*, *Toxopneustidae* and *Echinometridae*. The present work is then, in some way, a continuation of the „Ingolf“-work. The subjoined attempt at a natural classification of the regular Echini is the result of these very extensive studies.

By these researches I have made all possible efforts to overcome the numerous difficulties caused by the insufficient original descriptions of most of the species and by the consequently unreliable and very often wrong determinations by later authors. As far as possible I have examined the type specimens. I am very much indebted to the Carlsberg-Fond for having granted me assistance, enabling me to visit the large Museums of Europe: the British Museum, the Paris-, Berlin-, Hamburg-, Strassburg-, Genève- and Amsterdam-Museums, where so many types and such rich collections are preserved. Further I have in many cases been favoured by receiving in Copenhagen type-specimens of several species for direct comparison with my own material; I am thus obliged to Prof. DÖDERLEIN, Dr. MEISSNER, Prof. DOUVILLÉ, Prof. JOUBIN, Dr. CH. GRAVIER, Dr. DE MEJERE, Prof. BEDOT, Prof. THÉEL and Prof. ROSA. — Prof. BELL has kindly sent me to Copenhagen several interesting specimens which I had not time to examine sufficiently during my visit to London, and Dr. STEINHAUS has forwarded to me a rich collection of Echinids from the Hamburg Museum for examination. Finally in addition to several other interesting Echini Prof. S. F. HARMER has placed at my disposal the Echinids from the „Skeat“-Expedition, asking me to mention them in my work. All these gentlemen I beg hereby to receive my sincerest thanks.

By the examination of this large material I have found several undescribed species, mostly wrongly referred to other species. Of these new species I have given

short, but I think, sufficient descriptions and figures of the more prominent features. These species are:

Chaetodiadema japonicum.

Opechinus spectabilis.

Ptenrechinus variegatus.

— *maculatus*.

Microcyphus elegans.

— *annulatus*.

Gymnechinus versicolor.

— *inconspicuus*.

For the more difficult genera analytical tables of the species are given, which, I hope, will prove useful, so that future faunistic reports can be somewhat more reliable than is the case with several of the previous ones.

Copenhagen, November 1903.

TH. MORTENSEN.

Fam. Cidaridæ.

1. *Stephanocidaris bispinosa* (LAMCK.).

Pl. II. Figs. 3, 17, 18. Pl. IV. Fig. 30. Pl. V. Figs. 20, 25.

- Cidarites bispinosa*. LAMARCK. 1816. Hist. nat. des animaux sans vertèbres. T. III p. 57. (1840 T. III. p. 382).
- Stephanocidaris bispinosa*. A. AGASSIZ. 1872. Revision of Echini. p. 160, 393, Pl. I. c. Fig. 43, Pl. I. f. Fig. 1.
- Cidaritis Lütkeni*. DE LORIOI. 1873. Descr. de trois espèces d'Echinides. Mém. Soc. Sc. nat. Neuchâtel IV. p. 29. Pl. IV.
- Rhabdocidaritis bispinosa*. DE LORIOI. 1873. Ibidem. p. 33. Pl. V.
- Schleinitzia crenularis* (pro parte). STUDER. 1876. Über Echinodermen a. d. antarktischen Meere u. zwei neue Seeigel von den Papua-Inseln, ges. auf d. Reise S. M. S. „Gazelle“ um die Erde. Monatsber. d. Berliner Akad. 1876 p. 463.
- — STUDER. 1880. Übersicht über die während der Reise S. M. Corvette „Gazelle“ um die Erde 1874—76 gesammelten Echinoiden. Ibid. 1880. p. 865 (pro parte, non Fig.).
- Rhabdocidaritis recens*. TROSCHEL. 1877. Archiv f. Naturgesch. 43. p. 127. Tab. VIII. Nachträgliche Bemerkung. Ibid. p. 260. — Sitz. ber. d. Niederrhein. Gesellsch. (Phys. Sect.) 1877.
- Phyllacanthus annulifera*. RAMSAY. 1885 (1891). Catalogue of the Echinodermata in the Australian Museum. I. Echini. p. 2, 45.
- Stephanocidaritis bispinosa*. KOEHLER. 1895. Catalogue raisonné Echinod. îles de la Sonde. Mém. Soc. Zool. France VIII. p. 409.
- Rhabdocidaritis annulifera*. BEDFORD. 1900. On Echinoderms from Singapore and Malakka. Proc. Zool. Soc. p. 274. Pl. XXI. Fig. 1. a—d.
- Leiocidaritis bispinosa*. DÖDERLEIN. 1902. Bericht über d. v. Herrn Prof. Semon bei Amboina und Thursday Island gesammelten Echinoidea. (Semon. Zool. Forschungsreisen V. — Jen. Denkschr. VIII.) p. 695. Taf. I. VIII. Fig. 5—11.
- Stephanocidaritis bispinosa*. TH. MORTENSEN. 1903. Echinoidea I. Danish Ingolf Exped. IV. 1. p. 17, 19, 28 and 172. Pl. X. Fig. 17.
- Cidaritis (Stephanocidaritis) bispinosa*. DE MEJERE. 1904. Die Echinoidea der Siboga-Expedition. p. 4. Taf. I. 4, Taf. II. 14.

As indicated by the list of Synonyms given here, this species has caused much trouble to Zoologists; now, at length, through the researches of DÖDERLEIN and myself, especially by my examination of LAMARCK's type-specimen, it has been definitely settled which species is meant by the *Cidarites bispinosa* Lamarck; its systematic position — in the genus *Stephanocidaritis* — has likewise been determined with certainty. The *Cid. annulifera* Lamk., which has mostly been confounded with *Steph. bispinosa*, has been definitely shown to be either merely a variety of *Cidaritis baculosa* or, at most, a species very closely related to *C. baculosa*, belonging

to the genus *Cidaris* proper. (The type specimen of the *C. annulifera* has also been examined by myself (Ingolf-Echinoidea. p. 172)). That *Cidaris Lütkeni* de Lorient is only a synonym of *Steph. bispinosa* cannot be doubted; the type-specimen I have likewise examined. As for *Schleinitzia crenularis* I must refer to my work on the Ingolf-Echinoidea, p. 20, 173.

For detailed description and figures reference must be made especially to the works cited of DE LORIENT and DÖDERLEIN. A few features only need yet to be mentioned.

The ambulacral and interambulacral areas are figured in Pl. II. Fig. 3, 17. According to AGASSIZ (Op. cit. p. 394) the scrobicular circles are „ill defined, running into one another along the middle of the horizontal lines of contact“. On the specimens before me the scrobicular circles are well defined, with a complete circle of small tubercles. Evidently some variation may occur in this respect (comp. the description of *Cidaris Lütkeni*). In the ambulacral areas there is a series of tubercles inside the primary ones, placed opposite to or a little below the latter. On the inner part of the ambulacral plates a few (mostly two) small miliary tubercles are found.

AGASSIZ (Op. cit. p. 393) describes the abactinal system of the genus *Stephanocidaris* as being „thin, movable, resembling, in fact, far more the flexible anal system of Echinidæ proper than the massive abactinal system of Cidaridæ“, and this is, indeed, the only character given as distinguishing the genus *Stephanocidaris*. I am quite unable to see in the apical area of this species any such difference from that of other Cidarids; as will be seen from the fig. 18 Pl. II it has quite the usual form, and it is not more flexible than the anal system of other Cidarids. In fact it might well be supposed, as suggested by DE MEIJERE, that the specimens of AGASSIZ were not really referable to this species. Be that as it may, the species *bispinosa* must remain the type of the genus *Stephanocidaris*, which is characterized not by the apical system but by the structure of its pedicellariæ, as I have shown in my work on the Ingolf-Echinoidea. It may be pointed out that the tubercles on the outer edge of the genital and ocular plates and partly on the inner edge of the former are somewhat elongate, as remarked by DE LORIENT in his description of *Cid. Lütkeni*, though not so regularly as figured there (Op. cit. Pl. IV. Fig. 3). In the specimen figured here the madreporic plate has two genital pores, an interesting, but not uncommon abnormality.

In his *C. Lütkeni* DE LORIENT finds the upper radioles finely striated longitudinally, while in the rest of them „la surface de la tige est couverte de granules un peu épineux, disposés en séries longitudinales un peu irrégulières dont les intervalles, aussi larges qu'elles mêmes, sont garnis de verrues extrêmement fines“. In his *C. bispinosa* he finds them all finely striated longitudinally. It is true that some of the spines (the upper ones) may be longitudinally striated with very fine striae. Transverse sections of such spines, however, show that they have no outer layer,

which means that they are not yet full grown, even if they are as long as the other spines (comp. the beautiful researches of PROUHO). On the full grown radioles the outer layer is covered with small, branched, bushshaped thorns, arranged without order between the larger knobs or thorns; they may anastomose with their branches; transverse sections of the spines give figures very much like those of *Dorocularis papillata* (Ingolf-Ech. Pl. XI. Fig. 14, 31).

The secondary spines have no ampulla; the ambulacral spines are much darker than the interambulacral ones thus forming five dark, radiating lines on the animal. On the actinal side they may be somewhat hollowed in the outer end (especially those around the radioles), while those on the abactinal side are pointed.

The spicules are of the form usual in Cidarids; they lie in two series, which do not join on either side of the tube foot. In the lower part of the foot they are smaller, less spinous and rather scarce. — The globiferous pedicellariæ have been described and figured in the Ingolf-Echinoidea (p. 17. Pl. X. Fig. 17). The tridentate pedicellariæ (Pl. IV. Fig. 30) do not present marked peculiarities; the valves are a little apart below, when the pedicellaria is shut. — The walls of the intestine are closely packed with small, smooth, mostly oval calcareous bodies with a few holes, or with small, irregular, fenestrated plates (Pl. V. Fig. 25). In the mesenteries, genital organs, the organs of Stewart and along the radial vessels irregularly shaped plates are found (Pl. V. Fig. 20).

A young specimen of 5 mm. in diameter shows the features pointed out by DÖDERLEIN (Japanische Seeigel. p. 27 f.) as characteristic of young Cidarids; especially the obliquity of the pores is highly characteristic of the young as compared with grown specimens (Pl. II. Fig. 3.). In one thing this example differs from the common rule, there being already a complete circle of small tubercles around the areoles, which are thus completely separated. Pedicellariæ are found already at this size, the globiferous pedicellariæ are as yet small and not much lengthened, all being of the small form; tridentate ones are numerous and of the typical form. Spicules few and small.

Of this species a good many specimens belonging to the *forma typica* of DÖDERLEIN were taken on different places: at Koh Chuen and Koh Kram, between Koh Rin and Cliff Rock, between Koh Kahdat and Koh Kut, in 10—30 fathoms, on hard bottom. Also at Singapore a few small specimens were taken at 2—3 fathoms.

Two of the specimens were infested with *Stylifer*; one of them especially had many large individuals of this parasitic snail crowded on the apical area.

Fam. Diadematidæ.

2. *Diadema saxatile* (L.).

Pl. III. Figs. 22, 23, 29. Pl. IV. Figs. 26, 31, 34. Pl. V. Figs. 2, 5, 8, 12, 14, 15.

Echinus saxatilis. LINNÉ. 1758. Systema Naturæ. X. Ed. p. 664.

Cidarites diadema. LAMARCK. 1816. Animaux sans vertèbres. III. p. 58.

Diadema setosa. GRAY. 1825. Ann. Phil. X. p. 4¹).

- *Lamarckii*. ROUSSEAU. 1846. In: AGASSIZ & DESOR. Catalogue raisonné des Echinodermes. p. 45. (Ann. d. Sciences nat. 3 Ser. VI. p. 349).
- *setosa*. PETERS. 1854. Über die an der Küste von Mossambique beobachteten Seeigel und insbes. über die Gruppe der Diademen. Abhandl. d. Akad. d. Wiss. Berlin. 1854. p. 109.
- *Lamarckii*. Ibidem.
- *setosa*. BÖLSCHKE. 1865. Zusammenstellung der bis jetzt bekannten Echiniden aus der Gruppe der Diademen. Arch. f. Naturg. 1865. I. p. 325.
- *Lamarckii*. Ibidem.
- *Savignyi*. v. MARTENS. Über ostasiatische Echinodermen. Archiv f. Naturgesch. 1866. I. p. 155.
- *setosum* (pro parte). A. AGASSIZ. 1872. Rev. of Echini. p. p. 103, 274. Pl. II. b. 6—10. II. c. 6, IV a. 1. VI. a. 5. (The figures cited partly belong to *D. antillarum*.)
- — STUDER. 1880. Übers. über die während d. Reise S. M. Corv. Gazelle ges. Echinoiden. Monatsber. d. Berliner Akad. 1880. p. 868.
- — BELL. 1882. Note on the Echinoderm-Fauna of Ceylon, together with some Observations on Heteractinism. Ann. Nat. Hist. 5. Ser. X. p. 219.
- — (pro parte?). DE LORIOL. 1883. Catalogue raisonné des Echinodermes rec. par. M. V. Robillard à l'île de Maurice. Mém. Soc. de Phys. et d'hist. nat. de Genève. XXVIII. p. 13.
- — DÖDERLEIN. 1885. Seeigel von Japan u. d. Liu-Kiu-Inseln. Arch. f. Naturgesch. 1885. p. 85.
- *saxatile*. LOVÉN. 1887. On the Echinoidea descr. by Linnæus. Bih. K. Sv. Vet. Akad. Handl. XIII. p. 135.
- *setosum*. DÖDERLEIN. 1888. Echinodermen von Ceylon. Zool. Jahrb. Abth. f. Syst. III. p. 833.
- — SLUITER. 1889. Die Evertibraten a. d. Sammlung d. kgl. naturwiss. Vereins in Nederl. Indien in Batavia. Natuurk. Tijdschr. Nederl. Indie. 48. p. 288.
- — DE LORIOL. 1893. Echinodermes de la Baie d'Amboine. Rev. Suisse de Zool. 1893. p. 363.
- — SAVILLE KENT. 1893. The Great Barrier Reef of Australia, its Products and Potentialities. p. 42. Pl. 28. Chromopl. XI.
- — KOEHLER. 1895. Catalogue raisonné des Echinodermes rec. par M. Korotnev aux îles de la Sonde. Mém. Soc. Zool. de France. 1895. p. 410.
- — PFEFFER. 1896. Ostafrikanische Echiniden, Asteriden u. Ophiuriden, ges. von Dr. F. Stuhlmann im Jahre 1888 u. 89. Mitth. Mus. Hamburg. XIII. p. 45.
- — LUDWIG. 1899. Echinodermen des Sansibargebietes. Abh. d. Senckenb. naturf. Ges. XXI. p. 552.
- *saxatile*. BEDFORD. 1900. On Echinoderms from Singapore and Malacca. Proc. Zool. Soc. p. 227.
- — DE MEJERE. 1904. Echinoidea der Siboga-Exped. p. 49. Taf. XIV. Fig. 203.

Non: *Diadema antillarum* Philippi, nec *D. Savignyi* Mich. nec *D. globulosum* Ag.

This species, although it has been so very often mentioned in the literature, needs yet a closer examination. AGASSIZ thinks it impossible to distinguish the West-Indian form of *Diadema*, *D. antillarum* Phil., from the Indopacific

¹) Not seen by the author.

form¹⁾. Besides *D. saxatile* (*setosum*), he maintains only the West-American form, *D. mexicanum*, as a distinct species, though the differences in test and spines, which are pointed out as distinguishing characters (Rev. of Ech. p. 408), are, indeed, vary slight. But as „the pedicellariæ do not help us in the comparison“, as AGASSIZ states (loc. cit.), there seems to be nothing else left, and all the later authors, indeed, follow AGASSIZ in his view of the species of *Diadema*.

In spite of this universal agreement I am opposed to the representation of the *Diadema*-species given by AGASSIZ. I willingly grant that only very slight differences, scarcely sufficient to distinguish the species thereby, are found in test and spines; but in the positive assertion that the pedicellariæ do not help us in the discrimination of the species lies the fault. The pedicellariæ do indeed give excellent specific characters. A closer examination shows that *D. antillarum* is very well distinguished from *D. saxatile*, and that it is even more closely related to *D. mexicanum* than to the former species. Further it becomes evident from an examination of the pedicellariæ that *D. Savignyi* Mich. also, which has likewise been made a synonym of *D. saxatile*, is a distinct species, and I should not be surprised, if there eventually proved to be yet more well distinguished species of this genus.

The test of *D. saxatile* does not differ so much from the test of the other species that it can always be recognised with certainty by the characters found in it alone. The following features must be pointed out as more important distinguishing characters. The pore-areas are somewhat widened towards the actinostome, the actinal pores are much smaller than those above the ambitus, though their „peripodia“ are comparatively much larger. They are arranged in close transverse series (arcs) of three, and there is a primary tubercle only to about every three or four arcs of pores. Above this widened part of the pore areas there is a primary tubercle on each compound ambulacral plate — as in all the species of *Diadema* known to me. In a small specimen (35 mm. in diameter) this widening of the pore areas is as yet only slightly developed, in large specimens it is very conspicuous.

The naked part in the interambulacral areas is comparatively larger in this species than in the others; the uppermost one of the large tubercles forming the inner row is found on the fifth or sixth plate from above (beginning with the first complete one), and these tubercles are thus scarcely seen above the ambitus. At the lower end of the naked space there is a conspicuous white, angular spot, covering the inner end of the three last naked plates. Also on the living animal this is seen as a white spot. — The genital plates have mostly a distinct dark impression above the genital pore (evidently corresponding to the blue spot seen there in the living animal) (Fig. 1). This is, however, not an absolutely reliable character, as the

¹⁾ BÖLSCHKE (Op. cit.) has first maintained the Atlantic form to be the same species as the Indopacific form. v. MARTENS (Op. cit. p. 156) thinks that improbable, but since AGASSIZ in his Revision declared himself to be unable to distinguish the Atlantic from the Indopacific form, nobody has doubted the correctness of this view.

dark impressions may sometimes (though seldom) be indistinct. The number of tubercles on the apical plates is very variable, there may even be none at all. The form of the apical plates is also rather inconstant. In the figure the madreporic plate is seen to spread over the adjoining ocular plates and also over another small plate. The diameter of the apical system is distinctly larger in this species than in the other ones. (Comp. the measures given below).



Fig. 1. Apical system of *Diadema saxatile*. (Nat. size).

The pedicellariæ. PERRIER in his well known work on the pedicellariæ has given a good figure (Pl. 4. 1a) of the head of a smaller tridentate pedicellaria, the only one he has found; he names the species *D. savignyi*, but it must certainly be the true *D. saxatile*. (That the *D. turcarum* of PERRIER is synonymous with *D. saxatile* (*setosum*), as stated by AGASSIZ (Rev. of Ech. p. 104) and FOETTINGER¹⁾, I must doubt on account of the pedicellaria figured by PERRIER (Pl. IV. 2) being much broader than those of *D. saxatile*). A second form of pedicellariæ has been described and figured by FOETTINGER (Op. cit. p. 485. Pl. 28. 9.); it is named „claviform“ pedicellaria. The same form has been described and figured by DE MEIJERE (Op. cit. p. 50. Taf. XIV. Fig. 203). This is, I believe, all that is known of the pedicellariæ of this species, those figured by AGASSIZ (Rev. of Ech. Pl. XXIV. Fig. 38) evidently not belonging to *D. saxatile*, but, probably, to *D. antillarum*; his Fig. 39 is so little characteristic that it may be said to represent a very small tridentate pedicellaria of any of the *Diadema*-species.

Three kinds of pedicellariæ are found, viz. tridentate, triphyllous and ophicephalous (claviform) ones. The tridentate pedicellariæ occur in two forms, a large and a small one, which are, however, not sharply distinguished. In the large form (Pl. III. Fig. 22, 29. Pl. V. Fig. 2) — length of head upto 2 mm. — the valves are narrow, straight and wide apart, joining only at the point. The blade is rather deep, with a well developed smooth meshwork at the bottom reaching about the middle of the blade or even farther out. The edge is coarsely dentate in the whole length, only at the point the serrations are finer; in the lowermost part of the blade the edge with the dentations is mostly bent a little outwards. The neck of this kind of pedicellariæ is very short. In the smaller form of tridentate pedicellariæ (Pl. III. Fig. 23. Pl. V. Fig. 5, 8) — length of head c. 0,1—2 mm. — the valves are a little curved; they are wide apart, joining only at the point. The blade is essentially of the same form as in the large tridentate pedicellariæ, but there is no meshwork at the bottom and the edge is quite smooth or with a few dentations in the lower part. The point is a little widened, forming a distinct angle with the side-edge of the blade. The

¹⁾ Sur la structure des Pédicellaires gemmiformes de *Sphaerechinus granularis* et d'autres Echinides. Arch. de Biol. II. 1881. p. 485.

edge of this outer part has extremely fine serrations, visible only under high magnifying powers. The neck of this small form is long. On Pl. V. Fig. 14, 15 is figured a valve of a tridentate pedicellaria intermediate in size and form between the large and the small kinds. — The triphyllous pedicellariæ (Pl. IV. Fig. 26) are similar to those of the *Echinidæ*; the apophysis does not form a coverplate over the lower part of the blade; the edge is quite smooth. The neck is long. — The stalk of the tridentate and triphyllous pedicellariæ is mostly very long, up to c. 10 mm., and exceedingly thin, being formed of only a single, somewhat thorny, calcareous rod, or, in the large tridentate pedicellariæ, of two rods, whose thorns unite and form crossbeams between them. At the upper and lower ends, below the terminal swelling, the stalk is thicker, consisting of some more irregularly connected rods (Pl. IV. Fig. 31, 34.). This structure of the stalk, which has also been observed by DE MEJERE in this species and in *Chetodiadema granulatum* (Op. cit. p. 56), is very characteristic of the *Diadematidæ*.

The third kind of pedicellariæ, the ophicephalous or claviform ones, have no head, but three enormous glands on the stalk, which is short and thick, consisting of many rods irregularly connected by crossbeams, but not reaching to the point of the pedicellaria. They are about 1 mm. long. (Comp. FOETTINGER and DE MEJERE). DE MEJERE first pointed out that these claviform pedicellariæ are probably derived from ophicephalous pedicellariæ (Siboga-Ech. p. 56); that he is right therein, cannot be doubted, I think. The occurrence in *Chetodiadema granulatum* of claviform pedicellariæ with a head of undoubted ophicephalous structure together with the common claviform ones without a head proves it beyond doubt. The name „globiferæ“ used for these pedicellariæ by HAMANN (unfortunately also in „Bronn“) must then, as I have said in the „Ingolf“-Echinoidea (p. 169) be rejected on grounds of morphology as well as of priority, FOETTINGER having before HAMANN named them „ped. claviformes“; if we want a special name for them, which may be expedient we must call them claviform pedicellariæ, as has rightly been done by DE MEJERE.

The sphæridia do not present any peculiar features; they are placed as figured by LOVÉN (Études sur les Échinoidées. Pl. X. Fig. 89) for *Astropyga*.

With regard to the buccal membrane I must refer to AGASSIZ (Rev. of Ech. p. 275) and LOVÉN (Echinologica. p. 31–32, Pl. XII. Fig. 153). Some pedicellariæ (small tridentate and triphyllous ones) are found on the buccal plates and the other plates of the buccal membrane, but mostly in small numbers. According to LOVÉN part of these plates are „studded with verrucules, spinules and forcipes“; probably these „spinules“ must be stalks of pedicellariæ; true small spines I have only seen on the buccal plates; I have never found spines on all the buccal plates of the same specimen, and generally there are none at all. It must also be added that the „spicules“ in the buccal membrane, mentioned by LOVÉN, are the common fenestrated plates. (Of course there are all transitional forms between the larger fenestrated plates and the small irregular „spicules“ in the *Diadematidæ*). The gills are pro-

vided with irregular fenestrated plates as in the *Echinida* etc.; on the side lying towards the test these plates are enormously developed so as to form a strong ridge which in dried specimens mostly adheres to the test, as a continuation of the gillslit, and surpasses it in length: in reality it is part of the gill itself.

Auriculæ and dental apparatus do not seem to give reliable specific characters. Especially do I find the auriculæ very inconsistent in form and size.

The irregular, usually triradiate, branched spicules in the tube feet have been well figured by STEWART¹⁾, PERRIER (Rech. sur les Pedicellaires p. 135. Pl. 4. 1b) and BELL²⁾. They may be very few in number and present only in the upper part of the tube foot, or rather numerous and lying in the whole length of the foot. They are mostly arranged in three distinct series. The buccal tube feet, on the other hand, are very richly provided with spicules in form of large, fenestrated plates, a little curved according to the form of the foot, forming, as it were, a close mail to the foot. In the abactinal tubefeet there is often found in the partition wall a rather complicate calcareous network, formed of beams, which are widened to small fenestrated plates at their outer ends (Pl. V. Fig. 12). Otherwise spicules are not found in the abactinal tubefeet.

The spines have been very carefully studied by MACKINTOSH³⁾, to whose descriptions and figures I must refer. He thinks specific differences exist in the structure of the spines of the *Diadema*-species, and he finds *D. antillarum* to be so different from the other species in this respect that he is inclined to regard it as a distinct form, in spite of the assertion of AGASSIZ that it is synonymous with *D. saxatile* (*setosum*). Though I completely agree with MACKINTOSH that *D. antillarum* is a distinct species, I cannot agree with him as to the structure of its spines. I find them quite like those of *D. saxatile*, and upon the whole I cannot discover any reliable difference in the structure of the spines between any of the species of *Diadema*. The figure (Pl. XXXI. 8) given by MACKINTOSH as a transverse section of the median region of the shaft of a primary spine of *D. antillarum* is probably taken from an injured spine. In another treatise⁴⁾ MACKINTOSH mentions having found dimorphic spines in *D. mexicanum* „there being the usual long, tapering, verticillate spines with the normal *Diadema* structure which occur all over the test and a limited number of fusiform ones placed on the actinal surface. These are about half an inch in length, are longitudinally striated, not verticillate, as *Diadema* spines mostly are. . . — It is also interesting that on the same specimen there occur a few

¹⁾ On the Spicula of the Regular Echinoidea. Transact. Linn. Soc. London. XXV. 1865. p. 368. Pl. 48. Fig 17. a.

²⁾ Note on the Spicules found in the ambulacral tubes of the regular Echinoidea. Journ. R. microsc. Soc. 2. ser. II. 1882. p. 297—99. Pl. V.

³⁾ Researches on the structure of the spines of the Diadematidæ. Trans. R. Irish Acad. XXV. 1875. p. 519—58. Pl. XXXI*—XXXIII.

⁴⁾ Report on the Acanthology of the Desmosticha III. Further Observations on the Acanthology of the Diadematidæ. Ibid. XXVIII. 1883. p. 259.

spines which present characters intermediate in some ways between the other two". This is quite true, but it may be remarked that the statement holds good for all the species of *Diadema*. In all of them the primary spines of the actinal side are somewhat fusiform or clubshaped, indistinctly verticillate, especially at the point, longitudinally striated; while towards the abactinal side they gradually assume the typical form.

The living animal affords a most beautiful sight, with its well known blue spots, contrasting with the black colour of the test. The anal tube is about 1 cm. long, grey, with a band of yellowish red around the opening. The colouring of the spines (black banded or even quite white) is of no specific importance, as is also asserted by most previous authors. The small secondary spines are in a constant, lively circular motion, the large spines being much more slowly moved. — The habits of this most interesting sea-urchin are well known (SARASIN, DÖDERLEIN, SAV. KENT etc.), and my observations agree with those of these authors. The symbiosis of fishes (*Engraulis*?) with this species (SARASIN¹), COUTIÈRE²) I have not observed.

Numerous specimens were found at Koh Chang and Koh Kahdat; mostly they were seen in large numbers (c. 10—20) together in bare places between the corals, at a depth of 1—5 fathoms. Some specimens were taken at Pulo Redang by the Skeat Expedition.

The distribution of *D. saxatile* has hitherto (since Rev. of Ech.) always been said to be cosmopolitan in the warm region. As now the Atlantic form proves to be a distinct species, the occurrence of the true *D. saxatile* is restricted to the Indo-Pacific ocean. Here it seems to be universally distributed in the warm region (together with *D. Savignyi*). I have seen specimens from Zanzibar, Singapore, Siam, Cebu and Tahiti. From the West-American coast it is not known.

I shall now point out the characters by which the other species of *Diadema* are distinguished from *D. saxatile*.

D. antillarum Phil. The pore areas are not distinctly widened at the actinostome and the pores here not much smaller than those above the ambitus. As in *D. saxatile* there is not a primary tubercle on each compound ambulacral plate; in small specimens, however, there is a primary tubercle on each plate and such is evidently the case also in *D. saxatile*. It seems then that some of these tubercles — and spines — are absorbed as growth proceeds. The uppermost one of the large interambulacral tubercles of the inner series is found on the 4th or 5th plate from above, the naked space being smaller and the inner series of tubercles reaching higher above the ambitus than in *saxatile*. There are no dark impressions on the genital plates. Apical system small (see measurements given below). The triphyllous

¹) Über einen Lederigel aus dem Hafen von Trincomalie (Ceylon und seinem Giftapparat. Zool. Anzeiger. IX. 1886. p. 82.

²) Observations sur quelques animaux des récifs madréporiques de Djibouti. Bull. Mus. d'hist. nat. Paris. 1898. p. 238.

pedicellariæ as in *D. saxatile*. Besides the usual claviform pedicellariæ true ophicephalous pedicellariæ also occur; in very young specimens I have found only the latter form; in a specimen of 10 mm. diameter I have found both forms together; in larger specimens only the claviform ones seem to occur. The ophicephalous pedicellariæ are long-stalked without neck and without glands on the stalk. The valves (Pl. III. Fig. 16) are small but of the typical structure, with the usual arc below the articular surface. The tridentate pedicellariæ (Pl. III. Fig. 1, Pl. IV. Fig. 28) are very different from those of *D. saxatile*; the valves are rather short (head c. 1 mm), the blade is broad, spoonshaped, with rather few serrations on the edge, and they are wide apart, joining only at the point. These tridentate pedicellariæ are found as well on the test as on the buccal membrane; on the test some larger tridentate pedicellariæ (head 1.3 mm.) may be found, with narrower, simply leafshaped blades. These latter are more similar to those of *D. saxatile*, though different enough, especially in the edge being much less serrate. The small tridentate pedicellariæ (Pl. III. Fig. 10, Pl. V. Fig. 13) are more like those of *D. saxatile*, only mostly broader. In some small specimens (14—15 mm. in diameter) only small tridentate pedicellariæ were found. The spicules are like those of *D. saxatile*; they are found only in the outer end of the actinal tubefeet; in the abactinal ones neither common spicules nor supporting beams in the partition wall are found.

D. mexicanum Ag. As an essential character of this species AGASSIZ points out (Revision p. 408) that the abactinal system is larger in proportion than in *D. saxatile*, with a larger anal system and larger genital plates. There is, indeed, some difference in the size of the abactinal system in the species of *Diadema*, but since AGASSIZ's *D. setosum* contains both *D. saxatile* and *D. antillarum*, his statement must be corrected. The diameter of the apical system is, contrary to the statement of AGASSIZ, larger in *D. saxatile* than in the other species; in *D. antillarum* it is of about the same size as in *D. mexicanum*. The single measurement given by AGASSIZ for the abactinal system of *D. setosum* (Revision. p. 275) has probably been taken from a specimen of *D. antillarum*. I shall give some measurements of the three species named, to which *D. Savignyi* may be added.

<i>D. saxatile.</i>		<i>D. antillarum.</i>		<i>D. mexicanum.</i>		<i>D. Savignyi.</i>	
Test	Apical system.	Test	Apical system.	Test	Apical system.	Test	Apical system.
70 mm.	20 mm.	80 mm.	15 mm.	65 mm.	13 mm.	40 mm.	10 mm.
49 —	13 —	67 —	15 —	51 —	10.5 —		
45 —	13 —	56 —	10 —				
		55 —	10.5 —				
		45 —	10 —				

In the form and size of the apical plates and in the size of the periproct and the peristome I do not find any reliable difference. The pore-areas are as in *D. antillarum*; the pores are not much smaller towards the peristome. There are no dark impressions on the genital plates. The naked space in the interambulacral

areas rather small, the uppermost tubercle of the inner row being found on the fourth plate from above. The triphyllous and claviform pedicellariæ are like those of the other species; the large tridentate pedicellariæ (Pl. III. Fig. 20, Pl. V. Fig. 1) somewhat resemble those of *D. antillarum*, mostly having a distinct inward folding in the outer end (this feature may also be found sometimes in *antillarum*). The small tridentate pedicellariæ (Pl. III. Fig. 2) have the outer end of the blade a little broader and the corners towards the side-edge a little farther down than in *D. antillarum*. The spicules as in *D. antillarum*. These differences, however, are very slight, and it may be doubtful whether one could say with certainty, if a specimen be *D. antillarum* or *mexicanum*, if it were not known from which side of America it had come. It can scarcely be doubted that they were one species before the formation of the Isthmus. From *D. saxatile* both are easily distinguished, especially by their pedicellariæ.

D. Savignyi Mich. The pore areas are not widened at the peristome and the pores are not much smaller below than above the ambitus; there is a primary tubercle to every compound ambulacral plate. Mostly no distinct dark impression on the genital plates. The naked space in the interambulacral areas rather small; the uppermost tubercle of the inner row found on the 5th plate from above. The large tridentate pedicellariæ (Pl. III. Fig. 8. Pl. V. Fig. 7) — head c. 1,5 mm. — with the blade broad and flat, often somewhat irregular. There may be a pair of wingshaped crests on the back of the blade in the larger ones. In the smaller tridentate pedicellariæ (Pl. IV. Fig. 37, Pl. V. Fig. 9) the blade is broad, with the edge strongly serrate. On the buccal membrane some very small tridentate pedicellariæ are found, very similar to those of *D. mexicanum* (Pl. III, Fig. 6, Pl. V. 24). The actinal tubefeet are mostly richly provided with spicules, and often larger irregular fenestrated plates, arranged in three or four longitudinal series, occur in the whole length of the foot; especially at the base of the foot some large plates may be found. In the abactinal tubefeet two longitudinal series of the common triradiate spicules are generally found; they form no supporting beams in the partition wall.

That this is a distinct species I think is evident from the observations here given. That it is really the *D. Savignyi* Mich. I think certain. I have examined in the Museum of Paris a specimen named thus, from Zanzibar, Rousseau 1841. To be sure I found upon it only one large tridentate pedicellaria, which was so crushed that only the basal part was preserved; but in the tubefeet some large fenestrated plates occur, and as I have observed such spicules in no other species, I think we can safely use the name *D. Savignyi* for this species. The differences between *D. Savignyi* and *mexicanum* are evidently very slight. Upon the whole the three species *D. Savignyi*, *mexicanum* and *antillarum* are very nearly related, where as *D. saxatile* stands more distantly, being at once and easily recognized by its narrow tridentate pedicellariæ. *D. Savignyi* probably occurs together with *D. saxatile* in

the whole Indo-pacific region. In the Gulf of Siam and at Singapore, however, it does not seem to occur.

Besides *D. antillarum* and *Savignyi* AGASSIZ further names *D. globulosum* Ag., *paucispinum* Ag. and *nudum* Ag. as synonyms of *D. saxatile* (*setosum*). Of *D. globulosum* there is an authentic specimen in the Museum of Copenhagen, received from AGASSIZ (Society Islands). It is not the same species as *saxatile*. The large tridentate pedicellariæ (head 1 mm.) have broad valves (Pl. III. Fig. 7.). Very slight traces of dark impressions are found on the genital plates. The uppermost tubercle of the inner interambulacral row is found on the fifth plate from above. The specimen in hand is in no way more globular than specimens of *D. saxatile* of a corresponding size, so that the form of the test will not give any reliable difference; and I cannot decide from the single small specimen in hand, if other distinguishing characters exist in the structure of the test. Spicules as in *D. saxatile*. — Possibly this form will prove to be a distinct species, but for the present I must regard it as synonymous with *D. Savignyi*. — Of *D. paucispinum* we have likewise an authentic specimen (from the Sandwich Islands), but unfortunately it has been denuded, so that I have not been able to examine its pedicellariæ and spicules. I think it certain, however, that it is not synonymous with *D. saxatile*, on account of its small apical system, the small naked interambulacral spaces and the absence of dark impressions on the genital plates. Probably it is also synonymous with *D. Savignyi*. — *D. nudum* I do not know, and from the description¹⁾ nothing at all can be inferred with regard to its true place. — As for *D. Lamarckii* Rouss. I must state, after having examined the type specimen in Paris, that it is really identical with *D. saxatile*.

The SARASINS²⁾ mention a form of *Diadema* from Ceylon, which they take to be distinct from *saxatile*. It has a black analtube, and the blue spots are „in Reihen zusammengeschmolzen, so dass die Interambulacra an Stelle der blauen Fleckenreihen mit continuirlichen blauen Bändern geschmückt erscheinen“. Evidently this form is no *Diadema* at all but an *Echinothrix* (*diadema*(?)), as appears from the numerous small ambulacral tubercles (Op. cit. Taf. III. Fig. 16). Also v. UEXKÜLL³⁾ mentions „zwei Arten von *Diadema*“, which he has used for his experiments in Dar-es-Salaam. But he does not give any information as to the differences between these two species. As he likewise mentions a species of *Echinothrix* and one of *Astropyga*, it cannot well be supposed that his second species of *Diadema* belongs to a different genus. Probably v. UEXKÜLL's two species of *Diadema* from Dar-es-Salaam are *D. saxatile* and *Savignyi*, which seems to indicate, that the two species are easily distinguished in the living state.

¹⁾ Synopsis of the Echinoidea collected by Dr. W. Stimpson on the North Pacific Exploring Expedition. Proc. Acad. Nat. Sc. Philadelphia. 1863. p. 353.

²⁾ Ergebnisse naturwiss. Forschungen auf Ceylon. I. Die Augen und das Integument der Diademiten. 1887. p. 5. (Taf. III, 16).

³⁾ Die Wirkung von Licht und Schatten auf die Seeigel. Zeitschr. f. Biologie. 40. 1900. p. 448.

3. *Astropyga radiata* (Leske).

Pl. III. Figs. 15, 19. Pl. IV. Figs. 9, 17. Pl. V. Fig. 27.

Cidaris radiata. LESKE. 1778. Additamenta ad J. Th. Kleinii Naturalis Dispositio Echinodermatum. p. 52. Pl. 44. 1.*Astropyga radiata*. AGASSIZ & DESOR. 1846. Catal. raisonné des Echinodermes. p. 41.*Astropyga mossambica*. PETERS. 1854. Über die an d. Küste v. Mossambique beobacht. Seeigel. p. 112. Fig. 1.— *radiata*. v. MARTENS. 1866. Über ostasiatische Echinodermen. p. 157.

— — AGASSIZ. 1872. Rev. of Ech. p. 94, 420. Pl. XXIV. Fig. 40.

— *elastica*. STUDER. 1876. Über Echinod. a. d. antarkt. Meere u. zwei neue Seeigel a. d. Papua-Inseln. Monatsber. d. Berl. Akad. 1876. p. 464.

— STUDER. 1881. Übers. über die während d. Reise S. M. Corv. „Gazelle“ ges. Echinoiden. Ibid. p. 869.

— *radiata*. DE LORIO. 1883. Catalogue rais. Echinod. à l'île Maurice. p. 18.— *Freudenbergi*. P. u. F. SARASIN. 1887. Ergebn. naturw. Forsch. auf Ceylon. I. p. 16. Pl. 1.— *radiata*. DÖDERLEIN. 1888. Echinod. von Ceylon. Zool. Jahrb. Syst. III. p. 834.

— — SLUITER. 1889. Die Evertibr. a. d. Samml. naturw. Vereins Batavia. Echinoidea p. 290.

— — KOEHLER. 1895. Catalogue rais. Echinod. îles de la Sonde. p. 412. Pl. IX. Fig. 9.

— — DÖDERLEIN. 1902. Bericht über d. v. Herrn Prof. Semon bei Amboina u. Thursday Isl. ges. Echinoidea. p. 699. Pl. 59. Fig. 67.

— — DE MEIJERE. 1904. Echinoidea der Siboga-Exped. p. 56.

Other references to the old literature are found in AGASSIZ' „Rev. of Ech.“ p. 94.

After the careful description of this species lately given by DÖDERLEIN (Op. cit.) I need not say anything of the structure of the test; only a single fact I might point out, viz. that in the ambulacra primary tubercles are not found on all the ambulacral plates, but only on every second or third plate¹⁾, as is indeed well seen on the figures given by DÖDERLEIN. Only at the peristome (and in young specimens) there is an almost regular series of primary ambulacral tubercles, one to each plate. (For a most careful examination of the composition of the ambulacra in *Astropyga* comp. DUNCAN. On the anatomy of the Ambulacra of recent Diadematidae. J. Linn. Soc. Zool. XIX. 1885. p. 107. Pl. V. Fig. 9–10).

The primary spines of the abactinal side, especially the ambulacral ones are a little curved at the base; the fine secondary spines, abactinal and actinal are very distinctly curved. This fact also holds good for *A. pulvinata*. The milled ring is oblique, as figured by PETERS (Op. cit. Fig. 1 a.); this is a very prominent feature, especially on the large spines at the ambitus. A few small spines are found on the buccal plates.

The spicules (Pl. IV. Fig. 9) are small, irregular, triradiate bodies, arranged in mostly 5 longitudinal series; below the sucking disk they are rather numerous,

¹⁾ In the description of *A. pulvinata* in „Rev. of Ech.“ AGASSIZ has noticed this feature (p. 419), and perhaps the sentence „between most of the primaries a small secondary is intercalated“ in the description of *A. radiata* means the same thing (p. 420). *A. denudata* de Meijere has a primary tubercle on each ambulacral plate De Meijere Op. cit. p. 58.

in the lower part of the foot they are generally very scarce. In the abactinal tubefeet no spicules are found, except at the point, where a few spicules of the common form may be seen. The buccal tubefeet, on the other hand, are provided with large, irregular fenestrated plates, curved in accordance to the form of the foot. (They are arranged transversely to the longitudinal axis of the foot). The gills contain the usual irregular spicules, though there are very few in the finer branches. On the side turning towards the test there is a large, thick plate, as is usual in the Diadematids. According to BELL¹⁾ the spicules of *Astropyga* are anchorshaped, like those of *Micropyga*. This statement must have been caused by a wrong identification of a species of *Micropyga* as an *Astropyga* (Comp. below: „*Astropyga Freudenbergi*“); in all the species of *Astropyga* the spicules are triradiate.

The pedicellariæ of this species are up to the present time only very incompletely known. AGASSIZ (Rev. of Ech. Pl. XXIV. Fig. 40) has given a not very good figure of a valve of a tridentate pedicellaria, and KOEHLER (Op. cit.) has figured a claviform pedicellaria. Also LOVÉN has figured the claviform pedicellariæ of *Astropyga pulvinata* in his „Etudes sur les Echinoidées“ Pl. X. Fig. 89, without mentioning them, however, in the text. Nothing more is found in the literature on this subject — to my knowledge. — The pedicellariæ of *A. radiata* are as in *Diadema*: tridentate, triphyllous and claviform. The tridentate pedicellariæ occur in two forms; the first form, which is found in very different sizes, from c. 0.5 to more than 2 mm. (length of head), has the blade rather broad and deep, simply leafshaped. (Pl. III. Fig. 15. Pl. V. Fig. 27.) The edge of the blade is coarsely dentate in the lower part; in the outer part, where the valves join, the edge is straight and very finely serrate. In the smaller ones the valves join throughout almost their whole length, in the larger ones they are apart for about $\frac{2}{3}$ of their length. At the bottom of the blade there is, in the larger ones a well developed meshwork in continuation with the apophysis; in the small ones, there is only an indication of such a meshwork. The neck is quite short in the larger ones, well developed in the smaller ones. The other, small form of tridentate pedicellariæ (Pl. III. Fig. 19) is of the same form as the small ones in *Diadema saxatile*; the blade is narrow, with the outer end marked off at an angle with the lower part of the edge, which may be coarsely serrate in its whole length or with only a pair of indentations at the lower end. The valves are a little curved and join only at the point. The neck is very long. — The claviform pedicellariæ are of the common form and structure; no true ophicephalous pedicellariæ are found. The triphyllous pedicellariæ (Pl. IV. Fig. 17) are very beautiful, the holes in the outer part of the blade being so very elongate as to pass from the outer edge more than half way down. The apophysis forms a little coverplate over the lower part of the blade. The outer edge is smooth. The stalk of the pedicellariæ is as in *Diadema*.

¹⁾ Note on the spicules found in the ambulacral tubes of the regular Echinoidea. Journ. R. Microsc. Soc. 2 Ser. II. 1882. p. 298.

Two large, beautiful specimens were taken at Koh Kahdat, in 4–5 fathoms.

DÖDERLEIN regards *A. elastica* Studer and *A. Freudenbergi* Sarasin as synonyms of *A. radiata*. I must decidedly follow him therein. I have examined in the Berlin-Museum the type specimen of *A. elastica* and a specimen of *A. Freudenbergi* with regard to pedicellariæ and spicules and find them quite identical with those of *A. radiata*. As *A. pulvinata* Lamk. and *denudata* de Meijere differ markedly from *radiata* in regard to pedicellariæ, one might expect also to find some difference here, if they were really distinct species. The characters pointed out by the authors as distinctive have been shown by DÖDERLEIN to be quite unreliable. Evidently they cannot be maintained as distinct species, not to speak of a distinct genus as suggested by SARASIN. To be sure BELL¹⁾ maintains *A. elastica* to be distinct from *A. radiata*, and he is even right in some way. I have seen his specimens of *elastica* in the British Museum; they are so far from being identical with *A. radiata* that they are no *Astropyga* at all, but a species of *Micropyga* (*M. violacea* de Meijere, probably). I have not examined the disposition of the pores in these specimens, it is true, but the anchor-shaped spicules in the tubefeet show beyond all doubt that they belong to the genus *Micropyga*. — STUDER says of his *A. elastica*: „die ganze Schale war mit einer dicken gallertigen Epidermis überzogen“ (p. 869). I have not remarked the epidermis in my specimens to be especially jelly-like. — The type specimen of *A. mossambica* Peters I have also examined for pedicellariæ and spicules and found them to be identical with those of *A. radiata*.

The differences between *A. radiata* and *pulvinata* in the structure of the test have been most excellently represented by DÖDERLEIN. I may here point out the difference in the pedicellariæ. The tridentate pedicellariæ occur in one form only, all transitional forms being found between the largest and smallest ones. The largest ones found are about 0,8 mm. (head), with a short neck; the smaller ones have a long neck. The blade in the larger ones is mainly of the same form as in *A. radiata*, but the edge is more irregular (Pl. III. Fig. 3). Below there are a few large indentations, the edge being bent somewhat outwards; between these indentations and the outer, well marked portion, where the valves join, the edge shows a large irregular sinuation. There is very little meshwork in the bottom of the blade. The smaller forms are more like those of *radiata*. The triphyllous pedicellariæ (Pl. IV. Fig. 21) are not very different from those of *radiata*; the holes in the blade are less elongate and the apophysis does not form so distinct a cover-plate. The claviform pedicellariæ and the stalk of the pedicellariæ are as in *radiata*. The spicules are like those of *radiata*, but they are rather numerous in the abactinal tubefeet as well.

¹⁾ Report on the Echinoderms (other than Holothurians) collected by Dr. Willey. WILLEY. Zoological Results. II. 1899. p. 135.

AGASSIZ in his „Challenger“-Echinoidea p. 70. records *A. pulvinata* from the Arafura Sea (Chall. St. 188 and 190) and from off Honolulu. As this species is a littoral form and has its home on the pacific coast of America, it was a highly remarkable fact to find it on both sides of the Pacific; its eastern and western representatives were thus separated by the immense, deep tracts of the Pacific Ocean which are uninhabitable for littoral forms. It seemed then a little doubtful to me, whether the Challenger specimens really were *A. pulvinata*, the more so, as the description given of a young specimen indicates something rather different from the usual features in *Astropyga*, so that AGASSIZ is led thereby to the conclusion that „it is very evident from the above that in both these species (*A. radiata* and *pulvinata*) we have considerable variation in some of the characters which have thus far been employed to distinguish the two species“. I have examined all the Challenger-specimens and find that none of them are *Astropyga pulvinata*. The specimen of 19 mm. diameter (St. 190) described by AGASSIZ is *Chetodiadema granatum* (as I had already supposed from the description), and the specimen from St. 188 is the same species. The specimens from Honolulu are either *A. radiata* or perhaps a new species, very nearly related to it. The arrangement of the series of large interambulacral tubercles is as in *A. radiata*, the series being parallel to the outer edge of the area, not to the median line as in *pulvinata*. There is a primary tubercle only to every second ambulacral plate. The pedicellariæ are so very similar to those of *A. radiata* that scarcely a reliable difference can be found therein. The spicules are as in *radiata*. The abactinal spines are beautifully ringed with narrow redbrown and broad white bands; a few are uniformly redbrown with the point a little darker. The actinal spines are almost or quite white. The coloration of the abactinal side reminds one somewhat of *A. pulvinata*; the naked, forked band in the interambulacral area is brown, becoming gradually darker towards the median area and is very sharply marked off from the uniformly white median area by an intensely brown border. This beautiful coloration is very well shown in the two specimens, and the third specimen shows distinct traces of it. Perhaps a closer examination will show this form to be a distinct species or a well marked variety of *radiata*; for the present I must regard it as *A. radiata*. Unfortunately I have not younger specimens of *A. radiata* at my disposal; there is only one medium-sized specimen in the Copenhagen-Museum, and it is white, with ringed spines. Now it seems rather remarkable that the younger specimens should be light coloured with ringed spines and the large ones very dark with uniformly dark spines. If young specimens of a uniform dark colour be found besides the light coloured ones, I can scarcely doubt that they will prove to be two distinct species. (The ringed or uniformly coloured spines do not present a reliable character, as both kinds may occur in the same specimen.) Dr. DE MELIERE has kindly given me information of the colour of the young specimens from the „Siboga“-Expedition. The specimens from Amboina and Banda have the median

part of the interambulacra light coloured and contrasting with the dark colour of the outer part of the area. The other specimens are uniformly coloured, though in two of the specimens from St. 144 the median part of the interambulacra is somewhat lighter. Dr. MEIJERE does not think them to be two species, and, of course, I dare not assert the contrary without having examined the specimens in question. But I think the matter deserves a close examination based on large material. — SLUITER (Op. cit. p. 290) mentions *A. pulvinata* from Billiton and Krakatau; in „Die Echiniden-Sammlung des Museums zu Amsterdam“¹⁾ he refers these specimens to *A. radiata* on account of the presumed inconstancy of the distinguishing characters of *A. radiata* and *pulvinata*, which AGASSIZ thought he had proved. According to DE MEIJERE (Op. cit. p. 55) three specimens in the Museum of Amsterdam named *Astropyga radiata* are really *Chaetodiadema granulatum*, and probably the specimens from Billiton and Krakatau will prove to be the same species. That they are not *A. pulvinata* we may take to be certain.

In the „Challenger“-specimens from Honolulu I found a worm-like animal parasitic in the spines; it is found half buried in the point of the spine, which has become a little swollen on that account. Prof. SHIPLEY who has dissected two of these specimens thinks they are a parasitic Mollusc; but the material in hand is not sufficient for giving a description of this curious parasite.

4. *Chaetodiadema granulatum* Mrtsn.

Pl. I. Figs. 1, 3, 21–22. Pl. III. Fig. 11. Pl. IV. Figs. 1, 4, 13–15, 24, 32. Pl. V. Figs. 10, 18, 19, 22, 35.

Astropyga pulvinata (pro parte). AGASSIZ. 1881. Report on the scientific Results of the voyage of H. M. S. „Challenger“. III. Echinoidea. p. 70.

— — (?) SLUITER. 1889. Die Evertibr. a. d. Samml. d. naturwiss. Vereins Balavia. Echinoidea. p. 290.

— *radiata* (pro parte). SLUITER. 1895. Die Echiniden Sammlung des Museums zu Amsterdam. Bijdr. tot de Dierkunde. Afl. 17. p. 68.

Chaetodiadema granulatum. TH. MORTENSEN. 1903. *Chaetodiadema granulatum* n. g., n. sp., a new Diademid from the Gulf of Siam. Vidensk. Medd. Naturh. Foren. Kjøbenhavn. 1903. p. 1.

— — DE MEIJERE. 1904. Echinoidea d. Siboga-Exped. p. 54. Taf. III. Fig. 28, Taf. XI. Fig. 101, Taf. XIV. Fig. 205–208.

After the publication of my preliminary description of this interesting form DE MEIJERE gave an additional description and some figures of the specimens taken by the „Siboga“-Expedition. As I have yet several things to add, it will be desirable, however, that a complete description should be given here, as promised in the preliminary description.

The test is greatly depressed and very flexible as in the Echinothurids. Seen from the abactinal side the animal looks much like *Astropyga*. The apical area

¹⁾ Bijdr. tot de Dierk. afl. 17. 1895. p. 68.

(Pl. I. Fig. 1, 21) is large (21 mm. in the specimen of 90 mm. in diameter, on which the description of the test is based), of the usual diadematoïd structure, all the ocular plates being contiguous with the periproct in their whole width; the genital plates are not much elongated. Inside the ocular and genital plates there is a band of small, irregular plates, carrying small spines; the median part of the periproct is naked; there is (according to DE MEIJERE) some variation in the relative size of the naked median part of the periproct and the outer ring of plates. There is a large analtube; a small papilla covers each genital opening. (In *Astropyga* I have not been able to find such a papilla). A few small tubercles are found on the genital plates.

The interambulacral areas do not differ in any essential character from those of *Astropyga*, as regards the abactinal side. The uppermost one in the outer series of large tubercles is found on the 9th or 10th plate from above. It is said in the preliminary description that „there is no distinct series of secondary tubercles on either side of this series, only irregularly placed miliary tubercles“. This is not quite correct; there may be a rather distinct series of small tubercles on the almost naked upper interambulacral plates. This series can be traced down to where the large tubercles begin, and here a small tubercle at the upper and inner side of the scrobicular area may be seen to succeed those of the upper plates. There may thus be said to be an inner, longitudinal series of small tubercles along the outer series of large tubercles. The inner series of large interambulacral tubercles commence gradually on the following plates, the second series on the 10th or 11th plate, the third series on the 11th or 12th plate etc. There are 12 longitudinal series of large tubercles in all, arranged (on the actinal side) parallel to the median line of the area, as in *Astropyga pulvinata*. On the abactinal side, however, the series of tubercles are parallel to the outer edge of the area. The naked space with the blue spots, parallel to the outer series of tubercles, disappears suddenly at the ambitus, where a new series of tubercles occupies its place, as in *A. pulvinata*; in one of the specimens, however, the naked space disappears gradually at the ambitus between the two outer series of large tubercles, as in *A. radiata* and as is also the case in DE MEIJERE's specimen. In this specimen the direction of the inner series of large tubercles is a little more convergent towards the median line of the area than is otherwise the case. The large median interambulacral space is set with scattered miliary tubercles.

The ambulacral areas in the large specimens are not raised above the interambulacral areas; in small specimens I find them a little raised, as has been stated by DE MEIJERE. There is a primary tubercle on every compound plate, whereas in *Astropyga*, — viz. in *A. radiata* and *pulvinata*, — a primary tubercle is found only on every second or third plate. These tubercles are smaller than the interambulacral ones; the uppermost one is found on about the 10th plate from above. Inside the primary tubercles some small secondary and miliary tubercles

are found, the largest one mostly placed in the inner corner of the plate. Between the pores some small tubercles are found. The uppermost plates are quite naked.

In the character of the actinal side this form differs very much from *Astropyga* and, indeed, from all other Diadematids. The large tubercles only reach just below the ambitus; then they suddenly diminish very much in size, and from here the whole actinal side is covered by a very close and fine, uniform granulation, through which the limits of the plates cannot be traced. The tubercles forming this granulation are, however, not of the same size; some are a little larger, with distinct scrobicular area; the others are quite small miliary tubercles filling up all the spaces between the larger ones. In the outer part of the granulated portion there are, in both areas, indications of an arrangement of the tubercles in longitudinal series, in continuation of the series of large tubercles at the ambitus, but this arrangement is soon lost in the uniform granulation. At the edge of the peristome the test is bent strongly inwards, the ambulacral areas being somewhat sunken below the interambulacral areas. In the granulated part of the ambulacral areas the pores are very small, scarcely half as large as those at the ambitus and on the abactinal side; towards the apical system they are much larger; in smaller specimens the size of the pores is almost the same on both sides. In the outer part of the granulated portion in large specimens they are closely and irregularly arranged; in the inner part, from about half way to the peristome, they are arranged in a single, almost straight row, the pores being wide apart from each other, an arrangement the more curious as otherwise the pores are usually very crowded at the edge of the peristome. Where the arrangement of the pores in a single series commences the ambulacral area is a little widened and from here again it becomes gradually narrower towards the peristome.

An examination of the interior of the test gives a clear view of the structure of the abactinal ambulacral plates; they are constructed after the diadematoid type and they are not arranged in compound plates of two triplets as in *Astropyga*¹⁾. On the actinal side the structure cannot be seen distinctly in large specimens, partly on account of the plates overlapping each other irregularly, and not adorally alone. As the pores are so wide apart from each other, one might suppose it to be the case here as in *Kamptosoma* that some of the primary components of the plates had disappeared. That such is not the case, however, is sufficiently shown by the radial watercanal which has no rudimentary branches on it; all the branches and their ampullæ and tubefeet are well developed; but in the proximal part they are wide apart; whereas farther out they are very crowded. The plates are thus composed of the usual primary components, but these are excessively large.

¹⁾ Comp. DUNCAN: On the Anatomy of the Ambulacra of the recent Diadematidae. (J. Linn. Soc. Zoology. XIX. 1885.)

In young specimens the structure of the ambulacra is more easily seen to be typically diadematoid. The structure of the interambulacral areas is well seen from the inside, also on the actinal side. In accordance with the large size of the ambulacral plates the interambulacral ones are very large (high) at the peristome, very short and crowded in the outer part of the granulated portion, and here they seem to split up into several small, irregular pieces at the median end, a feature which is evidently something secondary¹⁾. In the other part of the test there is no indication of any division of the interambulacral plates; they are rather distinctly overlapping, the adoral edge being covered (as seen from without).

The peristome is small, about $\frac{1}{4}$ of the diameter of the test (22 mm. in a specimen of c. 90 mm. diameter of test); DE MEIJERE finds it even smaller, 11 mm. in a specimen of 60 mm. diameter. The buccal membrane contains numerous irregular, fenestrated plates; the buccal plates do not carry pedicellariæ or spines. The mouthslits are very small and indistinct; the gills are very small, containing the usual irregular spicules. The compact plate in the part of the gills turning towards the test is small and short.

The spines on the abactinal side and at the ambitus are slender and straight, $\frac{1}{3}$ — $\frac{1}{2}$ times as long as the diameter of the test; those just below the ambitus are flattened and a little widened at the point. The actinal spines are short, c. 8 mm. (in DE MEIJERE's specimen only 5 mm.), curved, very close set, giving the animal a curious, almost bearded appearance. Those at the peristome are a little longer. The milled ring is oblique as in *Astropyga*, even to an extreme degree in the spines at the ambitus (Pl. V. Fig. 10). The spines are verticillate as usual in the *Diadematidæ*; in the small spines the thorns may be bent outwards. In the small abactinal spines the whorls of thorns continue to the very point, in the small actinal ones the end

¹⁾ AGASSIZ has observed a similar splitting up of the interambulacral plates in *Astropyga* (Chall. Echinoidæ. Pl. X. a. fig. 9.) „into irregularly shaped independent plates, thus producing interambulacral areas which, as in the Palæechinidæ proper are composed of more than two vertical rows of plates . . . In *Astropyga* we find that the large interambulacral plates from the edge of the ambitus nearly to the abactinal system, as far as the external line of primary tubercles extends, are made up of two very distinct plates, so that in *Astropyga* as well as in *Phormosoma* (viz. *Echinosoma tenue*, — Chall. Ech. p. 95) we have an interambulacral area, in which the vertical zones are not composed simply of two rows of plates but of four“. (Chall. Ech. p. 72). Later on (p. 78) this splitting up of the plates in *Astropyga* is said to be „limited to a few plates on the actinal side(s) of the test“, and on p. 95 it is likewise said to be on the actinal side. DUNCAN (Op. cit. p. 110) has not been able to see this splitting up of the plates in *Astropyga*; but whether it usually exists or not, and, if it exists, whether it be on the abactinal or actinal side, it is certainly wrong to see a remnant of the palæechinoid structure therein. If it were really a palæechinoid remnant, it must evidently be found in the young specimens; but it has not been shown to exist in the young specimens, and it is rather probable that the splitting up of the plates in large specimens may be due simply to the breaking of the delicate plates by the handling of the specimens — both in *Astropyga*, *Chelodiadema* and *Echinosoma*, and, without doubt, all large forms with such delicate plates. — Unfortunately I have not had sufficient material of *Astropyga* for examining the question myself.

is without thorns (Pl. IV. Fig. 14). In transverse sections the spines look essentially like those of *Astropyga* (Comp. MACKINTOSH. Researches on the structure of the spines of the Diadematidae. Trans. R. Irish. Acad. XXV. 1875. p. 544. Pl. XXXIII. figs. 31—35). The central cavity is filled with a very open reticular network; the solid radii may be connected by a few transverse bars. In the flattened end of the spines at the ambitus the cavity is quite filled by a close meshwork. (Pl. V. Fig. 18—19).

The pedicellariæ are tridentate, triphyllous and claviform as in *Astropyga*. The tridentate pedicellariæ (Pl. IV. Fig. 1. Pl. V. Fig. 22, 35) have narrow, elongated valves, a little widened towards the end; the edge is strongly serrate; they are wide apart, joining only at the end. A little meshwork may be found at the lower end of the larger ones. Only one form of tridentate pedicellariæ is found, but they are very different in size, from c. 0,3 mm. to c. 1,5 mm. (length of head). In the larger ones the neck is short, in the small ones rather long. Sometimes also the stalk may be very short. The valves of the triphyllous pedicellariæ (Pl. IV. Fig. 24) have only some of the inner holes a little elongated, thus not presenting the beautiful aspect of those of *Astropyga*. The claviform pedicellariæ (Pl. IV. Fig. 4, 32) are especially large and numerous between the large spines just below the ambitus; on the abactinal side much smaller ones occur. As DE MEJERE has pointed out there may be found claviform pedicellariæ with the head developed, the valves being simple, with almost straight, finely serrate edges (Pl. III. Fig. 11), but undoubtedly of the ophicephalous type; these pedicellariæ alone would prove sufficiently that the claviform pedicellariæ of *Diadematidae* are developed from ophicephalous ones. The stalk of the pedicellariæ is as in *Diadema* and *Astropyga*.

The sphaeridiæ are globular, quite smooth; they are placed outside the granulated portion, almost at the ambitus, 3—4 to each pore-area; otherwise they are placed at the tubefeet as in other Diadematids, not in the median line of the ambulacral area. In a young specimen of 19 mm. (Challenger, see below) they proceed to the edge of the peristome. In another young specimen of 22 mm. diameter one of the sphaeridiæ in each series is placed in the granulated portion, the other outside between the large spines. It thus seems that the sphaeridiæ disappear from the granulated part as it becomes more densely covered with spines — as if they could not perform their functions in that dense forest of spines.

The spicules (Pl. IV. Fig. 13, 15) are triradiate, very slender, and are more or less distinctly arranged in longitudinal series; in the buccal feet they are more irregular. The sucking disk is small, the rosette slightly developed. In the abactinal tubefeet the spicules are exceedingly fine, more or less irregularly branched; they are found especially at the point of the foot. (In the preliminary description it is wrongly stated that spicules are wanting in the abactinal tubefeet). No spicules are found in the walls of the intestine and the genital organs.

The dental apparatus is very low, but otherwise typically diadematoïd, the teeth being unkeeled. The auriculae and their connecting ridges are bent very strongly inwards; the connecting ridge is very high, the auriculæ themselves forming only little projecting corners; the opening is rather small, triangular.

The colour of the abactinal side of the test is well shown by the beautiful figure given in DE MEJERE'S work (Pl. XI. Fig. 101), except that the white tubercles, seen on account of the spines being torn off, make the figure look a little different from the living, undamaged animal, in which the uniformly brownish spines do not contrast with the colour of the test. The blue spots do not extend below the ambitus; there is a series of large, mostly triangular spots down each side of the interambulacra along the inner side of the outer series of large tubercles, one to each plate, a large spot on each genital plate and some smaller spots irregularly scattered over the whole abactinal side. The actinal side, test and spines, are whitish.

Of this species a large, beautifully preserved specimen was taken 15 miles W. of Koh Kut, at 30 fathoms, and 4 large, but rather badly preserved specimens were taken 7 miles NW. of Koh si Chang, at 10 fathoms. In both localities the bottom was soft mud. Further a specimen was found in the Copenhagen Museum, labelled: Gulf of Siam, Salmin 1877. It was determined by LÜTKEN as *Astropyga* n. sp., but he never gave a description of it. — On the specimen from Koh Kut a small crab was discovered on the spines of the abactinal side and some small Cirripeds were found fixed to the point of some of the actinal spines.

It is very curious that this large and beautiful Echinid should not have been known previously, though being a littoral form, whose distribution, it might be supposed beforehand, could not be limited to the Gulf of Siam; from the localities recorded by the Siboga-Expedition it may be safely inferred that it is distributed over the whole Malay Archipelago. In fact it has been recorded several times, already, only under other names. DE MEJERE has shown that the specimens from the Bay of Batavia mentioned by SLUITER (Die Echiniden-Sammlung d. Museums zu Amsterdam p. 68) under the name of *Astropyga radiata* are really *Chaetodiadema granulatum*, and I am able to add two other instances. In the Challenger-Echinoidea p. 70 AGASSIZ describes under the name of *Astropyga pulvinata* a young specimen of 19 mm. diameter (from St. 190), which from the description appears to be a *Chaetodiadema*; after having examined the specimen in the British Museum I must positively assert it to be a young *Chaetodiadema*, and further I find the specimen from St. 188 (42 mm. in diameter) to be the same species. — Through the kindness of Prof. S. F. HARMER in Cambridge I have been able to examine some Echinids from the Maldive Islands (Collection J. S. Gardiner); I find among them a small specimen of *Chaetodiadema granulatum* from N. Malé, labelled *Astropyga* sp. juv., evidently one of the specimens mentioned by BELL¹⁾ as immature forms of *Astropyga* in his Report on

¹⁾ The Fauna and Geography of the Maldive and Laccadive Archipelagos. I. Part. 3. p. 231.

the actinogonidiate Echinoderms of the Maldive and Laccadive Islands. As it is of importance to know the structure of the young stages of the species, I shall make some remarks on this specimen.

Diameter 22 mm., height 8 mm., apical area 7,5 mm., peristome 5 mm. The naked part of the interambulacra is somewhat sunken, the ambulacra and the adjacent part of the interambulacra correspondingly raised. The uppermost one of the large interambulacral tubercles in the outer series is found on the 3rd or 4th plate from above (the small incomplete plates at the upper end not included); the next series begins on the following plate. Only two series of large tubercles are found on each side of the area. A series of secondary tubercles along the inner side of the large tubercles of the outer series continues until the apical system. A primary ambulacral tubercle is found on all the plates until the apex, except, of course, on the uppermost young plates. The apical system does not differ from that of the larger specimens; the genital papilla is well developed. The actinal side presents the features typical for the species. The pores are arranged in a quite regular single series, not crowded at the ambitus, and not so distant in the granulated part as in the large specimens; on the abactinal side they form rather distinct arcs; they are almost equally large over the whole test. Pedicellariæ and spicules as in the large specimens, only the spicules more numerous. The colour of test and spines is whitish; there is a small violet spot at the base of the spines, on the side turning towards the top. Blue spots as in large specimens.

The distribution of this species is thus shown to be from the Maldive Islands to New Guinea.

Among some Echinids from Japan (Sagami-See, 30 fathoms, coll. OWSTEN), sent to me for examination from the Hamburg-Museum, I find two *Astropyga*-like specimens (of 71 and 76 mm. diameter), which through the arrangement of the pores on the actinal side in a single series prove to belong to the genus *Chætodiadema*. They are, as regards their habitus, very similar to *C. granulatum*, from which species, however, they differ so much in several characters that they must form a separate species, for which I propose the name *Chætodiadema japonicum* n. sp.

The form of the test (Pl. II. Figs. 16, 19) is like that of *Ch. granulatum*. The abactinal side agrees with that species as regards the tuberculation; however, it looks rather different owing to the blue spots along the outer edge of the interambulacra being united so as to form a continuous line from the ambitus to the apical system; at the upper end the two lines of each area diverge, bending towards the ambulacra, making thus a very characteristic design (Pl. II. Fig. 16.). In the specimen figured from the abactinal side the thick skin of these lines is rubbed off, the white plating below thus making the lines much more prominent than when the dark skin is preserved. No blue spots are seen on the apical system.

The actinal side presents more considerable differences from *granulatum*. The tubercles diminish more gradually in size from the ambitus towards the

peristome, the series of primary tubercles not ending so abruptly close below the ambitus. There are eight longitudinal series of larger tubercles in each interambulacrum at the ambitus in both specimens: in *granulatum* specimens of a corresponding size have ten series at the ambitus. The tubercles are somewhat smaller than in *granulatum*, the tuberculation being upon the whole much scarcer than in that species. The longitudinal series are parallel to the median line of the area. The granulation of the inner part is much less close than in *granulatum*, and the limits of the plates are distinct (especially in the specimen figured from the abactinal side; unfortunately, the actinal side was so badly preserved in this specimen that it could not be figured).

The pores are very distinct along the whole actinal side, and are nearer together and much larger than in *granulatum*; they are not crowded at the ambitus. The spines are like those of *granulatum*, with oblique basis; those of the actinal side are rather coarse and not so close set, the bearded appearance being not very noticeable. The colour as in *granulatum*, excepting the arrangement of the blue spots. — The pedicellariæ are mainly like those of *granulatum*; the tridentate pedicellariæ, however, differ somewhat in form. They are shorter (c. 1 mm., head), often four-valved; the valves (Fig. 2) are not widened at the point, the edge of the lower part is bent outwards, and coarsely serrate; the smaller forms are like those of *granulatum*. The claviform pedicellariæ may have the head developed, the valves being similar to those of *granulatum* only more slender (Figure can not be given, as I have no good preparation of them). — The spicules are arranged more or less distinctly in four longitudinal series; they are tri-radiate, slender, but more irregular than in *granulatum*. In the abactinal tubefeet similar spicules may be found at the tip.

Through this new species of *Chaetodiadema* it becomes evident, that the very close granulation of the actinal side is not the essential character of this genus, this feature being much less developed in *Ch. japonicum* than in *granulatum*. The main character of *Chaetodiadema* is: the arrangement of the pores in a single series on the actinal side, by which feature it is at once distinguished from *Astropyga*, to which genus it has otherwise a great resemblance. Quite small specimens of *Astropyga* certainly will show the same character; this cannot, however, alter the value of the genus *Chaetodiadema*. The occurrence of a primary tubercle on all the ambulacral plates is no exclusive character of the genus, being found also in *A. denudata*, which species upon the whole seems to stand rather near *Chaetodiadema*.

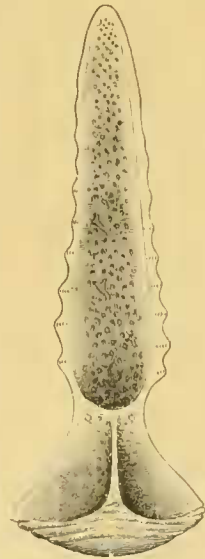


Fig. 2 Valve of tridentate pedicellaria of *Chaetodiadema japonicum*. (Seib. Obj. II. Oc III.)

5. *Echinothrix calamaris* (Pallas).

Pl. III. Figs. 5, 13, 17, 21, 30. Pl. IV. Fig. 7. Pl. V. Figs. 3, 11.

Echinothrix calamaris. AGASSIZ. 1872. Revision of Echini. p. 119, 413. Pl. III a. Fig. 1—2. Pl. XXXV. Fig. 10—15.— *desorii*. AGASSIZ. Ibidem. p. 120, 415.*Echinothrix Desori*. LORIOLE. 1883. Catalogue rais. des Echinodermes de Maurice. p. 14.

— — — 1893. Echinodermes de la Baie d'Amboine. p. 362.

— — KOEHLER. 1895. Echinodermes des îles de la Sonde. p. 411.

— *calamaris*. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. p. 698. Taf. LIX, 9, LXIII, 6.

— — DE MEIJERE. 1904. Echinoidea d. Siboga-Exped. p. 51.

For the numerous references to the old literature I must refer to AGASSIZ and for other less important references to the later literature to DE MEIJERE (Op. cit.).



Fig. 3.
The point of
an ambula-
cral spine of
Echinothrix
calamaris.
Zeiss. A. A.
Oc. 1.)

This species was not taken by the author in the Gulf of Siam, but the „Skeat“-Expedition took a specimen at the East Coast of Redang. Hence it may be mentioned here.

The structure of the test and the spines is well known from the works cited, so I need not say anything thereof. I shall only give a figure of the curious serrate point of the ambulacral spines (Fig. 3.); it may also be remarked that in large specimens there are spines on the buccal plates, this feature thus not being exclusive for the genus *Centrostephanus* among Diadematids, as said by AGASSIZ.

The pedicellariæ are quite insufficiently known. PERRIER¹⁾ has figured a valve of a small tridentate pedicellaria and a triphyllous pedicellaria, the figure of the latter (Pl. 4. Fig. 3a) being rather coarse, so that it is somewhat difficult to recognize in it the slender and elegant triphyllous pedicellariæ. DE MEIJERE (Op. cit. p. 53) has described the claviform pedicellariæ. The figures 33—36, Pl. XXIV in „Rev. of Ech.“ said in the explanation of the plate to be of *Ech. calamaris* are really *Ech. diadema*, under which species they are rightly mentioned in the text (p. 416).

The tridentate pedicellariæ occur in two forms. In the one, larger form (1.5 mm., head) (Pl. III. Fig. 5, 13, 30) the valves are wide apart, joining only at the end, which is somewhat widened, making a distinct angle with the lower part of the edge. The blade is a little curved, narrow, flat and filled with a coarse meshwork. The edge of the outer part is closely, but irregularly serrate; the lower part may be quite smooth or with more or fewer small teeth. The neck is rather short. This form, however, varies very much both in size and in shape. The part, where the valves join, may be larger (Pl. III. Fig. 30), equalling half the part of the blade, or they may even join throughout

¹⁾ Rech. sur les pédicellaires. p. 136. Pl. 4. Fig. 3 a—c.

almost the whole length; the blade is then simply leaf-shaped, rather deep with only a little meshwork in the bottom of the blade, and the whole edge closely serrate. This variety leads to the second form of tridentate pedicellariæ (Pl. III. Fig. 21. Pl. IV. Fig. 7), which may be as long as the first one but much more slender. The valves join in their whole length; the blade is narrow, deep, without meshwork; the edge is rather thick, the teeth are placed irregularly, not in a single series, along its whole length. (Also in the first form the teeth are placed irregularly). The quite small tridentate pedicellariæ (Pl. V. Fig. 3) are very like those of *Diadema saxatile*.

The ophicephalous pedicellariæ occur both in the form of claviform and of true ophicephalous ones. The latter are few in number and found only on the test, not on the buccal plates. The valves (Pl. V. Fig. 11) are small, without meshwork, the edge sinuate and serrate as usual. The stalk is long and thick; there is no neck. In the claviform pedicellariæ I have never found the head developed. The triphyllous pedicellariæ are essentially like those of *Diadema*, the shape only being a little different (Comp. Pl. IV. Fig. 23 of *Ech. diadema*); the edge is smooth. — The stalk of the tridentate and triphyllous pedicellariæ is, as in *Diadema*, constructed of one or two simple rods; in the latter case they are connected by crossbeams. — The spicules (Pl. III. Fig. 17) are triradiate, arranged mostly in two (in the abactinal) or three (the actinal tubefeet) distinct longitudinal series; in the abactinal tubefeet they are mostly larger than in the actinal ones. The buccal tubefeet are provided with large fenestrated plates as in *Diadema*.

With regard to *Ech. desori* I quite agree with DÖDERLEIN and DE MEJERE that it cannot be maintained as a distinct species; in its pedicellariæ and spicules it is quite like *Ech. calamaris*.

Echinolhria diadema differs markedly from *calamaris* in regard to pedicellariæ and spicules. The tridentate pedicellariæ occur in two forms. The one is large (2.5 mm. head), without a neck (Pl. III. Fig. 9, 14); [the valves join throughout half the length of the blade or more, the blade is simply leaf-shaped, rather deep, with a dense meshwork in the bottom; even in the basal part there is such meshwork on either side of the apophysis. The edge is rather thick, serrate in the whole length, the fine teeth being placed irregularly; also the edge of the basal part is serrate. (This form has been rather well figured by AGASSIZ, Rev. of Ech. Pl. XXIV 33—36). The second form (Pl. IV. Fig. 25, 36) is much smaller, c. 0.8 mm. (head), with a long neck. The valves are wide apart, joining only at the end. The blade is somewhat curved, narrow, almost flat, a little widened at the end, with a little meshwork in the lower part. The edge is smooth, and only in the outer part very finely serrate. The triphyllous pedicellariæ (Pl. IV. Fig. 23) are like those of *Ech. calamaris*. True ophicephalous pedicellariæ I have not found; the claviform ones have been figured by DE MEJERE (Siboga-Ech. Pl. XIV. Fig. 204). The spicules (Pl. III. Fig. 24, 27)

are irregular, elongated, fenestrated plates, arranged (in the abactinal) in two or (in the actinal tubefeet) three or more longitudinal series, the spicules with their axis parallel to the axis of the foot. Sometimes, however, they are of the common, triradiate shape. Some few bihamate spicules may also be found. The buccal tubefeet are as usual, provided with large fenestrated plates.

I may now take the occasion to give some additional remarks on the other *Diadematidae* not mentioned above, viz. the genera *Centrostephanus*, *Canopedina*, *Aspidodiadema* and *Dermatodiadema*. As regards the genus *Lissodiadema* I must refer to my description of it in Rev. Suisse de Zool. 1903. Vol. XI. p. 393, and for *Micropyga* to DE MEJERE (Siboga-Ech. p. 59). To the description of *Micropyga* I have only to add a few remarks on the pedicellariae. The tridentate ones have a well developed meshwork in the bottom of the elongate, rather narrow blade. The edge is coarsely serrate in the lower part, finely serrate with some larger teeth placed in rather regular distances, in the outer part, where the valves join. The small tridentate pedicellariae are finely serrate along the whole edge of the blade (Pl. V. Fig. 33, 37). The triphyllous pedicellariae have a distinct coverplate, and the outer edge is extremely finely serrate (visible only under high magnifying powers). (Pl. IV. Fig. 27.) The stalk of the pedicellariae consists of several very loosely connected rods, being thus very different from those of the other Diadematids.

Centrostephanus longispinus. The spicules are triradiate or H-shaped, arranged more or less distinctly in mostly four longitudinal series in the lower part of the tubefeet, irregularly in the upper part. In the abactinal tubefeet the spicules are rather numerous, especially towards the point of the foot. In the buccal tubefeet the spicules are large, compact, fenestrated plates. — The pedicellariae are of four kinds: tridentate, ophicephalous, globiferous and triphyllous. The tridentate pedicellariae (comp. KOEHLER: Notes Echinologiques. p. 27. Pl. IX. Fig. 10) are very elongate, up to almost 3 mm. (head); the neck is rather short. The valves (Pl. V. Fig. 29) join in about the outer third part of their length; the blade is narrow, leaf-shaped, with one or a few crossbeams at the lower end, otherwise without meshwork. The edge is slightly and irregularly serrate in the whole length. HAMANN says¹⁾ that there are two kinds of tridentate pedicellariae in this species, the one having smaller valves and being „schmächtiger“ than the other. I have been unable to find more than one form; perhaps it is the otherwise not mentioned triphyllous pedicellariae, which HAMANN has taken to be the second form of tridentate pedicellariae; he has given no figures of them²⁾. The ophicephalous pedicellariae have a rather long neck and the valves are of the typical structure (Pl. IV.

¹⁾ Histologie der Echinodermen. II. 3. p. 15.

²⁾ Having received from me a preparation of the triphyllous pedicellariae of *Centrostephanus longispinus*, Prof. HAMANN kindly informs me that he thinks he has confounded the triphyllous pedicellariae with the tridentate ones.

Fig. 2); they are found on the buccal plates and on the actinal side of the test, the latter ones generally a little larger, as observed by KOEHLER, but otherwise not differing in structure.

The globiferous pedicellariæ (*Globiferæ* HAMANN) are found only on the test; there are glands on the stalk; the head is very small, and may even be totally wanting (torn off?). No neck; the upper end of the stalk is widened, but not cupshaped. The blade (Pl. IV. Fig. 11) is narrow, provided with 4—6 large teeth in the outer end; often one of the teeth has a median position, but it is not larger than the other ones, and there is no canal on its upper side, in accordance with the fact that no poison gland is found on the valve. — It may be disputable whether these pedicellariæ are true globiferous pedicellariæ or only somewhat transformed ophicephalous ones. They remind one very much of the ophicephalous (claviform) pedicellariæ with large stalk glands in *Aspidodiadema*, but in these the valves are of a true ophicephalous structure. On the other hand they must certainly be taken to be homologous to the undoubted globiferous pedicellariæ of *Cænopedina* and *Stomopneustes*. Evidently we must conclude, that they are a sort of globiferous pedicellariæ, developed from the ophicephalous ones. It may be disputed whether the globiferous pedicellariæ of *Echinidæ* etc. are really homologous to these forms; but it seems not unreasonable. Of course they cannot be derived from such specialized forms as those of *Cænopedina*, but between the globiferous pedicellariæ of *Centrostephanus*, especially the forms with a median tooth, and those of *Hypsiechinus* and *Parechinus* the difference is not so very great. In *Centr. Rodgersii* there seem to be glands on the valves of the globiferous pedicellariæ; if that be really so (my material is not sufficient for stating it definitely), there can scarcely be any doubt that this suggestion of the origin of the globiferous pedicellariæ in *Echinidæ*, *Toxopneustidæ* and *Echinometridæ* is correct.

The triphyllous pedicellariæ are rather different from those of the other Diadematids. The blade is elongated and flat, the edge is quite smooth (comp. Pl. IV. Fig. 22 — of *C. Rodgersii*). They remind one very much of those in *Stomopneustes*. The stalk of the pedicellariæ is irregularly perforate. The sphæridiæ are elongate, pearshaped and smooth.

Centrostephanus coronatus I have not seen; from the description given by VERRILL it appears to be very nearly related to *C. longispinus*, but this cannot be affirmed definitely, before its pedicellariæ and spicules have been examined.

Centrostephanus Rodgersii. The spicules are as in *C. longispinus*, only more scarce in number. The pedicellariæ are of the same four kinds as in that species. The tridentate pedicellariæ are rather short, only c. 1 mm. (head); the neck is well developed. The valves (Pl. V. Fig. 34) are curved, wide apart, joining only at the point. The blade is narrow, almost flat, filled with meshwork; the edge is straight, with some few thorns, at the outer end sinuate, a little (irregularly) serrate. (A not very good figure of a valve of a tridentate (large-headed, long-stemmed) pedicellaria is given

by AGASSIZ in „Rev. of Ech.“ Pl. XXIV fig. 37). The ophicephalous pedicellariæ (Pl. III. Fig. 4) are essentially as in *C. longispinus*. AGASSIZ (Rev. of Ech. Pl. XXIV. 37') figures a valve of an ophicephalous pedicellaria without the usual arc below the basal part, and from this fact he concludes (Op. cit. p. 664) that „the buccal pedicellariæ of the Diadematidæ differ from those of the Echinidæ in having a solid base“. This cannot be held as a general rule; the base of the valves is only partly solid. In each ophicephalous pedicellaria two of the valves have the usual arc, only the third may have a solid base, but this even does not seem to be always the case. — The globiferous pedicellariæ (Pl. IV. Fig. 19) are like those of *C. longispinus*, only with more elongated blade and larger teeth at the point; there are not always glands on the stalk, those without glands being larger than the other ones. There seem to be glands on the outside of the valves. — Though *C. Rodgersii* looks very different from *C. longispinus*, there can be no doubt that they are nearly related, and they are rightly referred to one genus.

Through the kindness of Prof. DÖDERLEIN I have had occasion to examine the pedicellariæ and spicules of *Cænopedina* (*Hemipedina*) *mirabilis*. Meantime DE MEJERE has given an excellent description with figures of his *C. (H.) indica* (Siboga-Echinoidea. p. 65), and as the two species agree rather closely as regards pedicellariæ and spicules, I need only say a little of this very interesting form. — The spicules are like those of *C. indica*, and are arranged in two series as in that species. I have seen a single bihamate spicule in the gills. The globiferous and ophicephalous pedicellariæ (Pl. IV. Fig. 3, 5—6) present some small differences, as will be seen by comparing the figures given here with DE MEJERE's figures from *C. (H.) indica* (Pl. XVI. Fig. 237—40). The triphyllous pedicellariæ are quite like those of *indica*. Tridentate pedicellariæ are not mentioned by DE MEJERE for *C. indica*; in *C. mirabilis* I have found a few ones. They are small, simply leafshaped (Pl. III. Fig. 12) without meshwork in the bottom; the edge is a little sinuate, slightly and irregularly serrate. The valves apparently join in a little more than half their length; the neck is short. Possibly also a second form of tridentate pedicellariæ is found, with narrow, elongated blades, strongly serrate in the edge; but I dare not assert this positively. The stalk of the pedicellariæ is irregularly fenestrated.

The genera *Aspidodiadema* and *Dermatodiadema* have likewise been carefully treated by DE MEJERE; I may, however, give some additional remarks, especially on the Atlantic species, which are as yet insufficiently known.

Aspidodiadema tonsum. (This species is the first named in the Preliminary Report on the „Challenger“-Echinoidea, and is thus the type species of the genus). The spicules are arranged in two longitudinal series; they have been figured by DE MEJERE (Pl. XIII. 182). The tridentate pedicellariæ (Pl. V. Fig. 6) are elongate (c. 1 mm. — head) and slender; the valves join in almost their whole length; figures are given of them by DE MEJERE (Pl. XIII. 178—80). The neck is well developed, the stalk a single, thick, smooth rod. Also AGASSIZ has given a tolerable figure of a valve

of this form of pedicellariæ, under the name of „slender long-headed pedicellaria“ (Chall. Ech. Pl. XLIV. 15); but that the fig. 5. Pl. XLII represents a whole pedicellaria of the same kind requires a great deal of fancy to understand. DE MEJERE has found a second form of tridentate pedicellariæ with short blade and the upper edge of the apophysis serrate (Fig. 280); this form I have not observed. The triphylous pedicellariæ remind one rather much of those of the Echinothuridæ (*Asthenosoma* f. i.); the blade is quite closed in the lower part, the edges meeting and forming a coverplate, the outer end spoonshaped widened; only this widened part of the valves is joining, when the pedicellaria is closed (Pl. V. Fig. 31). The outer edge is finely serrate; DE MEJERE finds „hin und wieder kurze Zähnelung“ thereupon; I have always found the edge regularly serrate. The stalk is a single smooth rod, widened and irregularly fenestrated at the ends. The ophicephalous pedicellariæ occur in two very different forms: a small form, with small head, with or without large glands on the stalk, and another form with large head, without stalkglands; in both of them the head is supported directly on the end of the stalk, there is no neck. The valves of the small form are simple, without meshwork in the blade; the edge is finely serrate, as are the continuations of the apophysis. (Comp. the quite similar form in *A. microtuberculatum*, Pl. IV. Fig. 12). There is no structural difference between those without and those with stalkglands; the latter may be termed claviform pedicellariæ, being, of course, homologous with the claviform pedicellariæ of *Diadema* etc. The valves of the second form are large, almost triangular with the blade quite filled by a coarse meshwork (Pl. III. Fig. 26); the edge is somewhat sinuate, but otherwise thick and smooth; the point of the blade is bent inwards as a broad hook. The stalk of the ophicephalous pedicellariæ is not a single rod but is rather complicate, irregularly fenestrated, so that it is not distinctly seen to be formed of parallel rods¹⁾. The upper end of the stalk in the small form is beautifully cupshaped, that of the large form only thickened and rounded. — DE MEJERE regards the large ophicephalous form, which he has not found in this species, as a tridentate pedicellaria; I prefer to regard it as an ophicephalous pedicellaria, though its shape is rather different from the typical ophicephalous form. — It may be mentioned that there is a distinct genital papilla developed.

This species is recorded in the „Challenger“-Ech. from Cebu and the Kermadec-Islands, 100—630 fathoms, and from the Atlantic, off Macio, 1700 fathoms. I was at first doubtful whether the Atlantic specimens would really prove identical with the Pacific ones, both on account of the great distance and of the great difference in the depth of those localities. I have not, however, been able to find

¹⁾ AGASSIZ (Blake-Echini p. 25.) says that the „shaft“ of the „sheathed pedicellariæ“ (in *A. Jacobyi* and *antillarum*) consists of „a long, slender radiole, distinctly articulated“. This is wrong; it is not articulated only irregularly fenestrated.

any reliable difference between the Atlantic and the Pacific specimens, so it seems really to be true that this species has so wide a distribution.

Aspidodiadema Jacobyi. The spicules are as in *A. tonsum*; in the upper part of the tubefeet, however, they take the form of larger, irregular, fenestrated plates; they are arranged in two longitudinal series. Of the pedicellariæ only one form, the „sheathed“ ophicephalous („claviform“) ones have been mentioned and figured by AGASSIZ: as in *A. tonsum* tridentate, triphyllous and ophicephalous pedicellariæ are found. The tridentate pedicellariæ (Pl. V. Fig. 28) are rather small, c. 1 mm. (head); the valves are simply leafshaped, without meshwork in the bottom; they join in almost their whole length. The neck is short. The ophicephalous pedicellariæ occur in two forms, a large form without glands on the stalk and a small-headed form with large glands on the stalk (claviform), both with the head placed directly on the stalk, as in all the *Aspidodiadematidæ*. The valves in the large form (head c. 1.5 mm.) are elongated, with a coarse meshwork filling the blade (Pl. III. Fig. 25); the edge is thick, smooth and sinuate, the point forming a more or less distinct hook. The second form is provided with very large stalkglands (I have not found this form without glands), as is well seen in the figures given by AGASSIZ („Blake“-Echin. Pl. IX. a. fig. 9); the head is very small, with slightly developed valves, which present, however, an undoubted ophicephalous structure (Pl. IV. Fig. 10). The triphyllous pedicellariæ (Pl. IV. Fig. 20) essentially as in *A. tonsum*; the upper edge of the coverplate is a little produced over the blade, which may, however, also be the case in *A. tonsum*. The stalk of the pedicellariæ is irregularly fenestrate, but not articulate, as said by AGASSIZ (for the claviform pedicellariæ); in the claviform pedicellariæ the upper end of the stalk is cupshaped. — There are distinct genital papillæ.

Aspidodiadema nicobaricum Döderl. has been treated by DE MEIJERE (Op. cit. p. 46), to whose work I may refer. I may only add that I have found two sorts of tridentate pedicellariæ on a specimen, which Prof. DÖDERLEIN very liberally allowed me to examine; the one form is like that of *A. tonsum*, the other, much larger form, like that figured in Pl. III. Fig. 28 and Pl. V. Fig. 30 of *A. microtuberculatum*. The ophicephalous pedicellariæ (only claviform ones observed) seem to be constantly four-valved.

Aspidodiadema microtuberculatum Ag. Under this name AGASSIZ has confounded two species; since I have examined the „Challenger“-specimens in the British Museum, I can state this with certainty. The specimen from St. 134, off Tristan d'Acunha, accords well with the description and may thus be taken as the type of the species *microtuberculatum*. It has as yet retained the dark violet colour. There are spines on the buccal plates, a feature not mentioned by AGASSIZ; the figures, however, show several tubercles on the buccal plates, and the expression „when denuded“ used of them in the text may indicate the same thing. It must further be emphasized that the ambulacral plates have not all an equally large tubercle in

the inner part, but on every third plate there is a primary tubercle, larger than those of the other plates — in fact the usual arrangement among *Diadematidae* prevails here also, the only difference being, that the primary tubercle remains small. — Genital papillæ are found. The spicules as in *A. tonsum*. The tridentate pedicellariæ (Pl. III. Fig. 28, Pl. V. Fig. 30) are very characteristic; the valves join only for a very short space at the point, the blade is narrow and there is mostly a coarse meshwork filling the bottom almost to the point. There is a well developed neck; length of head c. 1–1.5 mm. The triphyllous pedicellariæ are somewhat variable in form, some of them being like those of *A. tonsum*, others having the outer part of the blade strongly bent inwards in the middle (Pl. IV. Fig. 18). The stalk of the tridentate and triphyllous pedicellariæ is irregularly fenestrated. Of the ophicephalous pedicellariæ I have only seen the claviform ones; but as there is evidently great variation in the occurrence of the large ophicephalous pedicellariæ in other species (e. g. *A. tonsum*), it can scarcely be doubted that they will be found in this species too. The valves of the claviform pedicellariæ are small and very simple (Pl. IV. Fig. 12). — The specimen from St. 299 is also a true *A. microtuberculatum*.

Of the other specimens from the „Challenger“ referred to this species those from off Macio and from St. 122 are certainly not *A. microtuberculatum*. There are no spines on the buccal plates; only in one of the specimens from off Macio I have found a single spine on four of the buccal plates, and of these two were partly transformed into sphæridiæ, looking very much like the figure I have given in my paper on Echinoderms from East Greenland¹⁾ of transformed buccal spines of *Echinus esculentus*. The pedicellariæ are like those of *A. antillarum*; in fact I think the specimens must be referred to that species. The absence of spines on the buccal plates distinguishes them from *A. tonsum*, as does also the size of the ambulacral tubercles. — The specimens from St. 298 I have not seen.

Aspidodiadema antillarum Ag. The ambulacral tubercles are not equally sized, those on every third plate being a little larger than the others, thus indicating the primary tubercle of the compound ambulacral plates in other Diadematids. This feature is well shown on Pl. IX. fig. 6 of the „Blake“-Echini. (Comp. *A. microtuberculatum*); it is no quite regular feature, however, sometimes the tubercles of several plates in succession being equally large. The buccal plates are naked, as are also the anal plates in young specimens; in larger specimens the latter are covered with spines. Genital papillæ are developed. Of the pedicellariæ AGASSIZ has given some rather bad figures, and the text, stating that „they are either long narrow-headed and long-stemmed, or short-headed and stout-stemmed, or short-stemmed and pyramidally headed“ („Blake“-Echini. p. 26), is in no way better. The three usual kinds of pedicellariæ occur. The tridentate and triphyllous pedicellariæ (Pl. IV. Fig. 16, 29, 35)

¹⁾ Meddelelser om Grønland. XXIX. 1903. p. 78. Fig. 1–3.

are very similar to those of *A. tonsum*. The ophicephalous pedicellariæ occur in a large and a small form. The large form (Pl. IV. Fig. 8, Pl. V. Fig. 4) has the valves rather elongate, as those of *A. Jacobyi*, but they are not so large as in that species; they are filled with an irregular meshwork, and the outer end of the valves forms a hook, especially large on one of the valves (see Pl. V. Fig. 4). The small form occurs both with glands on the stalk (Pl. IV. Fig. 33) and without such glands (Pl. V. Fig. 32); in both of them the upper end of the stalk is cupshaped. The valves (Pl. III. Fig. 18) are simple, without meshwork; the outer edge is somewhat sinuate, the whole form somewhat different from those of the preceding species.

Dermatodiadema indicum Döderl. and *amphigynnum* de Meijere have been carefully treated by DE MEIJERE (Siboga-Echinoidea p. 46 seq.); they prove to be essentially like the above mentioned species as regards pedicellariæ and spicules; the tridentate pedicellariæ of *D. indicum* are like those of *D. microtuberculatum*, those of *D. amphigynnum* are unknown, the tridentate pedicellariæ mentioned under this species by DE MEIJERE being the large ophicephalous pedicellariæ. *D. molle* Döderl. has tridentate pedicellariæ like those of *microtuberculatum* (Prof. DÖDERLEIN has kindly allowed me to examine the pedicellariæ of this species during my visit in Strassburg); otherwise it does not present important characters in its pedicellariæ. — The species *D. globulosum* Ag. and *horridum* Ag. I have not seen.

The genus *Dermatodiadema* has been established by AGASSIZ („Albatross“-Echini 1898. p. 76) for the species „having only small secondary tubercles in the ambulacral areas“; accordingly the species *microtuberculatum* and *antillarum* must be transferred to that genus; DE MEIJERE also rightly names these species *Dermatodiadema*. This difference in the ambulacral tubercles is indeed the only character distinguishing the two genera, and as there may be found an indication of larger primary ambulacral tubercles in species with small ambulacral tubercles, this character is evidently of little value. The pedicellariæ do not afford generic characters; only the tridentate pedicellariæ present two distinct types, but as both these types occur in both the genera, no generic character can be taken from them. — POMEL¹⁾ has established in 1883 the genus *Plesiadiadema* for *Aspid. microtuberculatum*; this name has then to be used instead of *Dermatodiadema*. DUNCAN²⁾ has later on, 1885, used the name *Plesiadiadema* for a fossil form, but of course it must be maintained in the sense of POMEL.

The claviform pedicellariæ of *Aspidodiadema* and *Plesiadiadema* are held by AGASSIZ to be of great value for comparative morphology. „These pedicellariæ“, he says in the „Blake“-Echini p. 25, „recall at once the remarkable sheathed spines . . . in *Asthenosoma Grubei*, they form an additional link in the chain proving that pedicellariæ are only modified spines. The diminutive heads of these pedicellariæ,

¹⁾ Classification méthodique et genera des Echinides vivants et fossiles. 1883. (Doct. Thesis)

²⁾ Quart. Journ. Geol. Soc. 41. 1885.

if completely resorbed, would leave us a sheathed spine identical with the sheathed spine of the Echinothuriæ; the existence in that family of club-shaped primary spines as in *Phormosoma bursaria* (um), the tip of which is still sheathed to a certain extent, shows how close is the relation of the sheathed spines to true pedicellariæ“. — I am decidedly opposed to this reasoning. The sheathed spines in *Asthenosoma* are spines of the structure typical in Echinothurids: beautifully fenestrated tubes ending in a fine point. In the „sheathed“ pedicellariæ of *Aspidodiadema* (and of all *Diadematidae*) the stalk is of an irregular structure quite different from that of the spines of the Echinothurids (or of any other Echinids), and even when the head of these pedicellariæ disappears, they do not get more accordance in structure with the spines, and they never can be homologized with the sheathed spines of *Asthenosoma*. The clubshaped spines of *Phormosoma bursarium* etc. are also true spines and can not present any proof whatever of the close „relation of the sheathed spines to true pedicellariæ“. Upon the whole I must confess that I cannot see any evidence of the pedicellariæ of Echinids being only transformed spines. In the Asterids, to be sure, there can be no doubt that some forms of pedicellariæ are transformed spines; but that that is true for all of them, I am not convinced (e. g. those of *Asterias*). The figures given of their development by AGASSIZ (Embryology of the Starfish. Pl. VIII. figs. 2—4) are much too undetailed to show them to be transformed spines, nothing definitely being seen there of the formation of the calcareous valves. But especially with regard to the pedicellariæ of Echinids no proof at all has been produced, showing them to be transformed spines. In fact the only argument produced by AGASSIZ in favour of this supposition is „the case of tripartite, pedunculated, Echini pedicellariæ attached as common spines are, upon a tubercle, surrounded by the peculiar smooth area called the scrobicular circle“ as is found in *Podocidaris*¹⁾. I cannot find any proof of the homology herein. As is well known, the scrobicular circle is only the impression of the muscular coat at the base of the spines; in large spines it is very distinct, in small ones indistinct or not to be seen at all. All pedicellariæ are attached to small tubercles and surrounded by a muscular coat at the base, just as in the articulation of the spines, only much more delicate. A scrobicular circle may certainly be found in many Echini around the tubercles of the larger pedicellariæ. But from this fact it only follows that pedicellariæ and spines are articulated in the same manner to the test, not at all that they are homologous. Neither can I see the least proof of their homology in the fact that the spines of Echinidæ present differences „fully as great as those observed in the pedicellariæ“ (Rev. of Ech. p. 669). It must be emphasized that no transitional forms are found between pedicellariæ and spines in Echinids; likewise the development of the pedicellariæ in Echinids is quite different from that of the

¹⁾ Rev. of Echini. p. 669.

²⁾ Comp. the Ingolf-Echinoidea I. p. 6. Pl. XII. 30 etc.

spines; from the first beginning it is easy to see, if we have a young pedicellaria or a spine before us, the pedicellariæ always commencing with a separate calcareous plate for each valve and one for the stalk, the latter developing from the upper end downwards¹⁾, whereas the spines always commence with a single calcareous plate, developing from the base towards the tip. I must decidedly maintain that the pedicellariæ of Echinids are not transformed spines, they are organs sui generis. The fact that some forms of pedicellariæ in Asterids are only transformed spines does not alter the fact of the Echinid-pedicellariæ being organs sui generis, as it may well be supposed that these organs have appeared independently in the two classes, being thus, strictly speaking, not homologous but only analogous structures. (Comp. CUVÉNOT. Études morphol. sur les Echinodermes. p. 368).

Classification of the Diadematids.

The family *Diadematidae* was established by PETERS²⁾ for the genera *Diadema*, *Astropyga*, *Echinothrix* and *Centrostephanus*, the two former genera, *Diadema* and *Astropyga* having previously been referred to the *Cidaridae* (GRAY) or to the *Echinidae* (by AGASSIZ & DESOR); the two latter genera, *Echinothrix* and *Centrostephanus* were established by PETERS in the work quoted. AGASSIZ in his „Revision of Echini“ assumed the family *Diadematidae* in accordance with PETERS, adding only the genus *Asthenosoma*. Later on he has added to that family the genera *Aspidodiadema*, *Dermatodiadema* and *Micropyga*, whereas *Asthenosoma* is transferred to the family *Echinothuriidae*. The genus *Cænopedina* (*Hemipedina*) AGASSIZ refers, as well known, to the „*Triplechinidae*“, though he otherwise regards it as being a subgenus of *Pseudodiadema*. POMEL (Op. cit.) adopts the same arrangement, only *Cænopedina* is referred to the *Pedinidae*. An essentially different classification is given by DUNCAN in his important „Revision of the Genera and great Groups of the Echinoidea“³⁾. The genus *Aspidodiadema* is made the type of a distinct family *Aspidodiadematidae*, and the family *Diadematidae* is divided into four subfamilies, viz. I. Subfam. *Diadematinae*, with the genus *Diadema*, under which *Centrostephanus*, *Hemipedina* and the fossil *Microdiadema*, *Diademopsis* and *Echinodiadema* are placed as subgenera, and the fossil genera *Placodiadema*, *Heterodiadema*, *Codiopsis*, *Pleurodiadema*, *Magnosia* and *Cottaldia*. II. Subfam. *Diplopodiinae*, with the genus *Micropyga* and the fossil genera *Diplopodia*, *Pedinopsis*, *Acanthechinus*, *Phymechinus*, *Asteropsis*, *Diplogtagma* and *Plistophyma*. III. Subfam. *Pedininae*, with the genera *Echinothrix* and *Astropyga* and the fossil genera *Pedina* (with the subgenus *Pseudopedina*), *Echino-*

¹⁾ Ingolf-Echinoidea. I. p. 6. Pl. XII. fig. 30 etc.

²⁾ Über die an der Küste von Mossambique beobachteten Seeigel und insbesondere über die Gruppe der Diademen. Abh. d. Berl. Akad. 1853.

³⁾ Journ. Linn. Soc. Zoology. XXIII. 1891.

pedina, *Stomechinus*, *Micropedina*, *Heterocidaris*, *Polycyphus* and *Codechinus*. IV. Subfam. *Orthopsinae*, comprising no recent form, but the fossil genera *Orthopsis*, *Eodiadema*, *Peronia*, *Echinopsis* and *Gymnodiadema*. — This classification has been adopted with a little modification by GREGORY in the „Treatise on Zoology“, ed. by RAY LANKESTER (Part III. Echinoderma. 1900). Lastly LAMBERT¹⁾ arranges the recent and fossil genera of Diadematids in the subfam. *Diademinae*, with the Tribus: *Astropyginae* and *Aspidodiademinae*; subfam. *Tiarinae*, with the Tribus: *Hemicidarinae*, *Eodiademinae*, *Pseudosaleninae*, *Pseudodiademinae*, *Diplopodinae* and *Glyphocyphinae*; subfam. *Pedininae*, with the Tribus: *Orthopsinae* and *Climapedinae*. LAMBERT's classification is „évidemment encore artificielle et elle conserve l'inconvénient de separer d'une facon trop absolue des genres que rapprochent une partie de leurs caractères“ (Note sur quelques Éch. éoc. de l'Aude p. 512) and as he names only a few of the genera of his different tribus it is rather difficult to get a quite clear understanding thereof. DUNCAN's attempt at giving a natural arrangement of the recent and fossil genera seems to me the more important; in any case it is very radical and consistent. However, I cannot adopt his classification. To be sure my knowledge of the fossil Echinids is rather small and exclusively based on literary studies; but trusting to my researches on the recent forms I think it not too bold to draw some conclusions also as regards the fossil forms. Now there cannot be the least doubt that DUNCAN's classification is quite unnatural as regards the recent Diadematids, and so it is probably not better for the fossil ones. Thus LAMBERT, whose knowledge of the fossil forms is so very profound and extensive, says of this classification that it presents „une inégalité et une confusion regrettables, car les genres successivement énumérés n'ont souvent entre eux que des rapports très éloignés. Ainsi on y voit figurer comme sous-genre d'*Acrocidaris* polypore, à tubercules crénelés et perforés, un Arbacien, *Acropeltis*, oligopore, à tubercules lisses et imperforés. *Diplopodia* à tubercules crénelés, *Pedinopsis* à tubercules lisses, *Acanthechinus* pourvu de fossettes et *Phimechinus* polypore, à tubercules imperforés, s'y succèdent“ (Éch. éoc. de l'Aude. p. 513).

DUNCAN considers the structure of the ambulacra as being of primary taxonomic importance, whereas the „very popular and useful“ arrangement of the genera by the existence or not of crenulation and perforation of the primary tubercles is too artificial, „for the physiological importance of the superficial structures is exceedingly small“. — „It may be stated as a general truth, that if these genera be classified by the ornamentation of the tubercles, groups possessing very diverse ambulacra will be associated“. — I have already in the Ingolf-Echinoidea I. (p. 12—13) on treating the classification of the Cidaridae criticized DUNCAN's opinion, that structures „of no physiological importance“ cannot be used as systematic characters.

¹⁾ Note sur quelques Échinides Éocènes de l'Aude (Bull. Soc. Géol. d. Fr. 3. Sér. XXV. 1897) and: Étude sur quelques Échinides de l'Infra-Lias et du Lias (Bull. Soc. de l'Yonne. 1899).

D. K. D. Vidensk. Selsk. Skr., 7. Række, naturvidensk. og mathem. Afd. I. 1.

I must here again affirm that characters of primary importance for classification are often found in structures of evidently very little physiological importance (spicules f.i.); I even think that we must especially look out for systematic characters among the features likely to be of little or no physiological importance, such structures being little liable to be altered for any special use. For the rest it is rather rash to declare without reservation — and without proofs by physiological experiments — that the physiological importance for instance of the superficial structure of the tubercles is exceedingly small, and on the other hand that the number of interradial coronal plates in Cidarids for instance is of physiological importance.

The structure of the ambulacra, on which DUNCAN lays so great stress, is certainly of the highest systematic importance, and it is DUNCAN's great merit to have shown by his careful studies on the anatomy of the ambulacra of the Echinids that different types of compound plates exist¹⁾. He establishes six types, viz. the cidaroid, the diadematoid, the arbacoid, the cyphosomatoid, the diplopodous and the echinoid types. Of these the arbacoid, diplopodous and cyphosomatoid structures are only modifications of the diadematoid; I can only admit three different types, viz. the cidaroid type, with simple primaries which do not combine to form compound plates, the diadematoid type in which the adoral primary plate is a small plate, the following one being the largest, and the echinoid type, in which the adoral component is the largest, and never a demi-plate, the following being smaller. But these features do not present generic or family-characters; they are of higher value. All the families of Ectobranchiata may be arranged in three groups: namely with simple²⁾, or diadematoid or echinoid ambulacra; these are then characters of orders. The minor variations in the ambulacral structure may present generic characters, but scarcely any of higher value. Thus DUNCAN, when using exclusively the minor variations in the ambulacral structure for subdividing the family *Diadematidae*, gets such surprising results as to make *Centrostephanus* and *Hemipedina* subgenera of *Diadema* and to place *Echinothrix* and *Astropyga* (to which *Chaetodiadema* and *Lissodiadema* should probably have been added) in another subfamily. After the diagnoses given by DUNCAN of the two subfamilies *Diadematinae* and *Pedininae*, one might as well transfer all the genera of the *Diadematinae* to the *Pedininae* and vice versa.

We must then seek other characters for grouping the genera, and there we meet at once the „very popular and useful“ structures, the crenulation and perforation of the tubercles. In fact DUNCAN has not given any reason for neglecting the characters from these structures, except the assertion that „it may be stated, as a general truth, that if these genera (viz. the group of the fossil genera which is characterized by having numerous small tubercles placed actinally and at the

¹⁾ On the Anatomy of the Ambulacra of the recent Diadematidae. J. Linn. Soc. Zool. XIX. 1885.

On the Structure of the Ambulacra of some Fossil Genera and species of Regular Echinoidea. Quart. Journ. Geol. Soc. XLJ. 1885.

²⁾ The simple ambulacra do not make a very distinct type, all ambulacra being originally simple.

ambitus, but then ceasing more or less, as for instance *Codiopsis*, *Gymnodiadema*, *Plistophyma* and *Polycyphus*; and also *Orthopsis* and its allies) be classified by the ornamentation of the tubercles, groups possessing very diverse ambulacra will be associated". This may perhaps be possible; but it is certain that by leaving this feature out of consideration DUNCAN has been induced to make e. g. *Hemipedina* a subgenus of *Diadema*, two forms so different that they must certainly be referred to two different families. And nobody will deny, I am sure, that the recent forms must afford the test of the value of characters used in the classification of the fossil forms. — By using the perforation of the tubercles as a systematic character among the recent Ectobranchiata no forms are grouped together, which by their other characters are shown to stand apart from each other. This is then a character of great value. Among the Diadematids no instance is known, of allied genera having the one perforated, the other imperforated tubercles. Among the Cidarids there is one instance: the genus *Tylocidaris* Pomel having imperforate tubercles, whereas in all the other recent and fossil Cidarids the primary tubercles are perforate. The crenulation of the tubercles is a less reliable character, as there are instances among the recent forms where undoubtedly allied genera, such as *Echinothrix* and *Lissodiadema*, *Temnopleurus* and *Pleurechinus*, have the one crenulated, the other noncrenulated tubercles. It is, however, in many instances a very useful character, which ought not to be neglected. Further the structure of the spines is of some importance; by neglecting the characters afforded thereby DUNCAN is induced for instance to make the important fossil genus *Pseudodiadema*, characterized by its smooth, solid spines, synonymous with *Diadema*, whose spines are hollow and verticillate. As with the crenulation of the tubercles, however, the characters afforded by the structure of the spines must be used very cautiously. — Finally the pedicellariæ and spicules afford some characters of importance, though not so many as in the other regular Echinids. That the characters afforded by the structure of test ought not to be neglected either, needs scarcely be mentioned. — Having thus made clear which characters can be used in the classification we may proceed to discuss the relations of the different genera.

The genera *Plesiadiadema* and *Aspidodiadema* are undoubtedly the most primitive of recent Diadematids. DUNCAN establishes for them a special family, *Aspidodiadematidæ*, distinguished from the *Diadematidæ* by the large, narrow, ringed apical system, formed by broad basals and broad intervening radial plates, by having few interradiial plates, each with a large primary perforate and crenulate tubercle, and by the straight ambulacra with numerous low primary plates, with or without primary tubercles. Though I find none of these characters very important or exclusive, I quite agree with DUNCAN that these genera ought to form a separate family. A few characters are to be added from the spicules and pedicellariæ. The spicules are elongate, mesially widened and fenestrated plates, whereas in the *Diadematidæ* proper the spicules are triradiate or larger irregular plates. With regard

to the pedicellariæ the most distinct character is found in the triphyllous ones; they remind one very much of those of the Echinothurids, the blade being closed by a large coverplate in the lower part and the outer edge being serrate. The ophi-cephalous pedicellariæ occur in two different forms, a small form with or without glands on the stalk, and a large form without glands on the stalk. (To be sure the large form has not been found in all the species, but as its occurrence in the species, where it is known, is rather variable, it is allowable to suppose, that it will be found on further examination of more material in all the species). The characters here pointed out are certainly very slight, but added to the characters found in the test they can only strengthen the view that these two genera form a separate family of Diadematids. GREGORY unites *Aspidodiadema* with the genera placed by DUNCAN in the subfam. *Orthopsinæ* and makes thereof a family *Orthopsidæ*. I cannot agree with GREGORY herein. *Aspidodiadema* and *Plesiodiadema* have perforate and crenulate tubercles, but among the genera of „*Orthopsinæ*“ this is the case only in *Eodiadema*. This genus (according to the description) must certainly be very nearly related to *Aspidodiadema*; but none of the other genera placed here by GREGORY have perforate and crenulate tubercles, and I can accordingly see no proof that they are nearly related to *Aspidodiadema*. We must then retain the name *Aspidodiadematidæ* for this family, as well because of its priority as because it is very doubtful, if the genus *Orthopsis* does really belong to this family.

The separation of the genus *Micropyga* from the fam. *Diadematidæ* is certainly correct. In addition to the characteristic arrangement of the pores in sets of two it differs from all other Diadematids by its peculiar anchorshaped spicules. (BELL in his Note on the Spicules of the Regular Echinids¹⁾ has already expressed some doubt, if *Micropyga* has been rightly united with the Diadematids, on account of these spicules). On the other hand I must doubt the correctness of referring it to the subfamily *Diplopodinae*, nay even the correctness of making a family or subfam. *Diplopodinae* at all. It is a very obvious character, to be sure, the arrangement of the pores in sets of two; but it is also certain, I think, that all the forms with the pores arranged in this way are not really nearly related. It may well be supposed that the biserial arrangement has originated independently in different families, as is certainly the case with the polyporous arrangement. If we look to the ornamentation of the tubercles in the genera referred to the *Diplopodidæ*, we find that *Diplopodia* and *Pedinopsis* have perforate and crenulate tubercles, *Acanthechinus* and *Asteropsis* imperforate, crenulate, and *Phymechinus*, *Diplotagma* and *Plistophyma* imperforate, noncrenulate tubercles. Finally *Micropyga* alone has perforate noncrenulate tubercles. This „family“ accordingly seems very unnatural. It ought also to be remembered that in *Phymosoma* the pores are biserial on the abactinal side; but even DUNCAN has not ventured to be consistent and transfer this genus to the

¹⁾ Journ. R. microsc. Soc. 2. Ser. II. 1882. p. 298.

„*Diplopodidae*“. The biserial arrangement of the pores is then evidently of no more systematic value than the trigeminate and multigeminate arrangement. It seems to me most correct to make a separate family *Micropygidæ*, n. fam., for the genus *Micropyga* and leave it undecided, whether any of the known fossil genera may be referable to the same family. This family is characterized above all by its anchorshaped spicules, further by wanting ophicephalous pedicellariæ either in the form of true ophicephalous or of claviform ones; the triphyllous pedicellariæ are finely serrate in the outer edge, and the stalk of the pedicellariæ consists of several slender rods, almost not united except at the ends. The tubercles are perforate, non-crenulate. The biserial arrangement of the pores and the deep actinal cuts may probably not be family characters; that the extraordinary development of the abactinal tubefeet in *M. tuberculata* is no character of high order is proved by the fact that in *M. violacea* these tubefeet are simple.

The arrangement given by DUNCAN and GREGORY of the families (or subfamilies) *Diadematidæ* and *Pedinidæ* looks most extraordinary. *Cænopedina* (*Hemipedina*) is placed with *Centrostephanus* and *Diadema* (by DUNCAN the two former are even regarded as subgenera of *Diadema*) in the fam. *Diadematidæ*, *Echinothrix* and *Astropyga* (to which *Chaetodiadema* and *Lissodiadema* should probably have been added) in the fam. *Pedinidæ*. The diagnoses of these two families are: Fam. *Diadematidæ*. Ambulacral plates compound near the ambitus, the pairs of pores in simple vertical series or in arcs of three (or more). Fam. *Pedinidæ*. Ambulacral plates compound and the pore-pairs triserial. — I wonder if anybody can find in these diagnoses a single feature, which really differentiates these two families! When reviewing the characters found in the recent genera, *Diadema*, *Astropyga*, *Chaetodiadema*, *Echinothrix*, *Lissodiadema*, *Centrostephanus* and *Cænopedina*, we find that *Lissodiadema* and *Cænopedina* have perforate, noncrenulate tubercles and smooth spines (solid in *Cænopedina*), whereas the other genera have perforate, crenulate tubercles and verticillate (hollow) spines. The spicules are simple, tri-radiate bodies, or larger, irregular, fenestrated plates (*Diadema Savignyi*, *Echinothrix diadema* and *Cænopedina*). In the two latter a few bihamate spicules may be found, but, though of great interest, this feature can certainly not be of any classificatory value. With regard to the pedicellariæ there are some facts of importance to note. The tridentate pedicellariæ do not present any features of more than specific importance; in the triphyllous pedicellariæ it is to be noticed that the edge is smooth and the blade open, without coverplate. The ophicephalous pedicellariæ occur in *Astropyga* and *Chaetodiadema* only in the form of claviform pedicellariæ, seldom (*Chaetodiadema*) with the head developed. In *Diadema (antillarum)* and *Echinothrix* they occur both as claviform and as true ophicephalous pedicellariæ, with the head placed directly, without neck, on the stalk. In *Centrostephanus* they also occur in both forms, but there is a well developed neck on the true ophicephalous ones, and in the claviform ones the head is especially developed with teeth on the valves,

so that this form is probably to be regarded as a primitive globiferous pedicellaria. Finally in *Cænopedina* the latter form has been developed into a curious form of globiferous pedicellariæ, with no glands on the stalk; there are true ophicephalous pedicellariæ. The stalk of the pedicellariæ is a single rod, or two rods connected by crossbeams in the triphyllous and tridentate pedicellariæ, irregular, complicated in the ophicephalous ones. In *Cænopedina* it is irregular and complicated, also in the triphyllous and globiferous pedicellariæ. (*Lissodiadema* is imperfectly known as regards the pedicellariæ.) There are thus several differences found in the pedicellariæ, but scarcely any of higher classificatory value. We are thus referred to the structure of the test and spines for characters from which to group the genera, and there we note as the most important fact that in *Cænopedina* the tubercles are smooth, whereas in all the other genera (except *Lissodiadema*) they are crenulate. The apical system of *Cænopedina* is small, with all the ocular plates excluded from the anal system, very different from the large apical system of other Diadematids, in which the ocular plates are more or less directly in contact with the anal system. Finally the stout solid spines are very different from the hollow spines of *Diadema* etc. There are no blue spots on the test. — There can certainly be no doubt that *Cænopedina* must be referred to a different family from the rest of the Diadematids, viz. to the fam. *Pedinidæ*; and to this family I would also refer such fossil genera as *Pedina* Ag., *Pseudopedina* Cotteau, *Mesodiadema* Neumayr, *Micropedina* Cotteau, *Leiopedina* Cotteau, *Echinopedina* Cotteau, *Hemipedina* Wright, *Echinopsis* Ag., *Diademopsis* Desor, *Phymopedina* Pomel, *Hecistocyphus* Pomel, *Orthopsis* Cotteau, *Miorthopsis* Pomel, *Gymnodiadema* Lorient, *Palæopedina* Lambert. — Among the genera referred by DUNCAN to the *Pedinidæ* the genera *Stomechinus*, *Polycyphus* and *Codechinus* have imperforate, noncrenulate tubercles, and *Heterocidaris* perforate, crenulate tubercles; these evidently cannot belong to this family. I thus quite agree with POMEL in his view of the family *Pedinidæ*.

The other recent genera of Diadematids must certainly be referred to one family, the *Diadematidæ*. To be sure, they are not all very nearly related; thus *Astropyga* and *Chætodiadema* form one group, *Diadema* and *Echinothrix* another group, and *Centrostephanus* again stands apart from the other genera. But to refer these groups to different families would certainly not be correct, the characters distinguishing the groups being only of secondary importance (form of the test, the blue spots, the pedicellariæ). The genus *Lissodiadema*, I think, must be referred to the same family, in spite of its smooth tubercles and spines; as I have pointed out in the description of this form it suggests *Echinothrix* in several important characters, and it must probably be regarded as an aberrant form of that type. — Among the fossil genera *Placodiadema* Duncan and *Helikodiadema* Gregory must probably be referred to this family.

A number of fossil genera have been united by POMEL in a family *Pseudodiadematidæ*, differing from the true *Diadematidæ* in having solid, smooth spines.

I dare not assert, if it be correct to make a separate family of these forms, though I think it probable. At any rate DUNCAN is wrong in making *Pseudodiadema* a synonym of *Diadema*. As no recent form of Pseudodiadematids is known, it is impossible to have a full knowledge of their characters. The genus *Lissodiadema*, to be sure, has only smooth spines, but it can scarcely have any close affinity to the *Pseudodiadematidæ*, all its characters pointing more towards *Echinothrix*.

I must here once more draw attention to the genus *Stomopneustes*. I have already (Ingolf-Ech.) shown it to be very different from the *Echinometridæ*, with which family it was hitherto associated. On the contrary it reminds one in several respects of the *Diadematidæ*. The spicules are irregular like those of the Diadematids, though more complicated. The globiferous pedicellariæ recall those of *Centrostephanus* and its triphyllous pedicellariæ are quite like those of the latter genus. It is very difficult to say, if these similarities are only characters of convergence. The difference in the ambulacra (echinoid in *Stomopneustes*) and the teeth (keeled in *Stomopneustes*) is evidently of more importance than the characters furnished by spicules and pedicellariæ. It is very unfortunate that no living representatives of forms like *Stomechinus* are found. It might well be supposed that *Stomopneustes* is a highly specialized descendant of such forms. At any rate the family *Stomopneustidæ* must be upheld, representing the lowest stage of the Echinoidea with echinoid ambulacra.

Glyptocidaris crenularis has been referred to the *Phymosomatidæ*¹⁾ by POMEL and DUNCAN; AGASSIZ, though referring it to the „Triplechinidæ“, even thinks it to belong to the genus *Phymosoma*. I think, POMEL and DUNCAN are right in placing it in the family *Phymosomatidæ*. The ambulacra are diadematoid (see Rev. of Ech. Pl. VI. 2)²⁾; the spicules are large fenestrated plates (Rev. of Ech. Pl. XXXVIII. 19). Globiferous pedicellariæ are found, but their structure unfortunately cannot be seen from the figure given by AGASSIZ (Rev. Pl. XXV. 4).

Having now discussed the relations of the genera of Diadematids, I may give my opinion of the interrelations of the families of the regular Echinoidea. Since I have made a special study of the recent forms of all these families³⁾, except the small and well characterized groups of the *Salenidæ* and *Arbaciidæ*, my views on their affinities may not prove unfounded, although they differ considerably from those of previous authors.

AGASSIZ (Rev. of Ech.) does not give a more elaborate system, he only names all the families of regular Echinids one after another, all being united into

¹⁾ As pointed out by LAMBERT (Ét. sur quelques Échinides de l'Infra-Lias et du Lias. p. 54) the name *Cyphosoma* cannot be used, as it rightly belongs to one of the Coleoptera.

²⁾ In this figure the plate above the adoral one is a small demiplate, the following being the largest.

³⁾ The family Temnopleuridæ is treated below.

POMEL.

- Les Globiformes.
- Palechinida.
- Nearechinida.
- Holostomata.
- Cidaridæ.
- Echinothuridæ.
- Glyphostomata.
- Diadematidæ.
- Diadematinæ.
- Pseudodiadematinæ.
- Pedininæ.
- Hemicidarinæ.
- Phymosomidæ.
- Saleninæ.
- Phymosominæ.
- Arbacinæ.
- Temnechininæ.
- Psammechininæ.
- Stomechininæ.
- Schizechininæ.
- Heliocidarinæ.
- Echinometrinæ.

DUNCAN.

- Subclass I. Palæechinoidea.
- II. Euechinoidea.
- Order. Cidaroida.
- Fam. Cidaridæ.
- Order. Diadematoida.
- Suborder. Streptosomata.
- Fam. Echinothuridæ.
- Suborder. Stereosomata.
- Fam. Saleniidæ.
- Hemicidaridæ.
- Aspidodiadematinæ.
- Diadematidæ.
- Subfam. Diadematinæ.
- Diplopodiinæ.
- Pedininæ.
- Orthopsinæ.
- Fam. Cyphosomatidæ.
- Arbaciidæ.
- Temnopleuridæ.
- Subfam. Glyphocyphinæ.
- Temnopleurinæ.
- Fam. Echinometridæ.
- Subfam. Echinometrinæ.
- Polyporinæ.
- Fam. Echinidæ.
- (Order III. Holoctypoida.
- IV. Clypeastroida.
- V. Spatangida.)

GREGORY.

Subclass I. Regularia endobranchiata.

Order 1. Bothriocidaroida.

— 2. Cysticidaroida.

Fam. Palæodiscidæ.

— Echinocystidæ.

Order 3. Cidaroida.

Fam. Lepidocentridæ.

— Archæocidaridæ.

— Cidaridæ.

— Diplocidaridæ.

Order 4. Melonitoida.

Fam. Palæechinidæ.

— Melonitidæ.

— Lepidesthidæ.

Order 5. Plesiocidaroida.

Fam. Tiarechinidæ.

— Lysechinidæ.

Subclass II. Regularia ectobranchiata.

Order 1. Diademoida.

Suborder 1. Calycina.

Fam. Saleniidæ.

— Acrosaleniidæ.

Suborder 2. Arbacina.

Fam. Hemicidaridæ.

— Arbaciidæ.

Suborder 3. Diademina.

Fam. Orthopsidæ.

— Diadematidæ.

— Diplopodiidæ.

— Pedinidæ.

— Cyphosomatidæ.

— Echinothuridæ.

Subfam. Pelanechininæ.

— Echinothurinæ.

Suborder 4. Echinina.

Fam. Temnopleuridæ.

Subfam. Glyphocyphinæ.

— Ortholophinæ.

— Temnopleurinæ.

Fam. Triplechinidæ.

— Strongylocentrotidæ.

— Echinometridæ.

LAMBERT.

Subclass. Gnathostomata.

Order. Plagiocysta.

Suborder. Cystocidaroida.

Order. Holostomata.

Suborder. Bothriocidaroida.

— Perischoechinoida.

— Plesiocidaroida.

— Cidaroida.

Fam. Cidaridæ.

Order. Glyphostomata.

Suborder. Streptosomata.

Fam. Echinothuridæ.

Suborder. Stereodermata.

Fam. Diadematidæ.

Subfam. Diademinæ.

Tribus. Astropyginæ.

— Aspidodiademinæ.

Subfam. Tiarinæ.

Tribus. Hemicidarinæ.

— Eodiademinæ.

— Pseudosaleninæ.

— Pseudodiademinæ.

— Diplopodinæ.

— Glyphocyphinæ.

Subfam. Pedininæ.

Tribus. Orthopsinæ.

— Climapedinæ.

Fam. Echinometridæ.

Subfam. Phymosominæ.

Tribus. Saleninæ.

— Coptosominæ.

— Salmacinæ.

Subfam. Arbaciadinæ.

— Echininæ.

Tribus. Orthoporinæ	Prototiarinæ.
	Cotteaudinæ.
	Temnechinæ.
— Oligoporinæ	Pleurechinæ.
	Triplechinæ.
	Schizechinæ.
— Polyporinæ	Sphærechinæ.
	Trochalosominæ.
	Heliocidarinæ.
	Acrocladinæ.

one suborder, *Desmosticha* Haeckel. In the „Challenger“-Echini the same course is followed, and it is here (p. 18) even attempted in a mathematical way „to show once for all how futile it must be to carry on the attempts of tracing the genealogy of this or that group of animals“, in case the Echinoidea. There are about twenty variable terms in Echini, „which may be, of course, combined in all possible ways one with the other, and which are capable in their most restricted limits of at least 2^{19} combinations; and when we remember that in the 225 genera which we have thus far recognised, we may imagine any one or all the twenty variables affecting the relationship of each of the genera, it seems somewhat hazardous, to say the least, to attempt anything beyond the broadest indications of the outlines of the relationship“. This may be theoretically true, but in practice there remain only some few characters to be taken into consideration when trying to trace the relationship of the forms, and the matter is not so difficult as it looks from the mathematical problem as put up by AGASSIZ.

More elaborate classifications have been given especially by POMEL, DUNCAN, LAMBERT and GREGORY¹⁾; they are represented above in a tabular view.

Also the system of BELL²⁾ ought to be mentioned, viz.

Entobranchiata.

Fam. 1. Cidaridæ.

Ectobranchiata.

Ser. α . (Palæoproctous.)

Fam. 2. Salenidæ.

Ser. β . (Neoproctous.)

Subser. I. (polylepid.)

Fam. 3. Echinothuridæ.

Subser. II. (decalepid.)

Fam. 4. Arbaciadæ.

— 5. Diadematidæ.

— 6. Echinidæ.

As seen by these tabular views there is very little accordance among authors on the classification of the regular Echini. Leaving aside here the question, as to the propriety of subdividing the whole class into Regularia and Irregularia, or into Gnathostomata and Atelostomata, I shall here deal only with the Regularia.

The *Palæechnoidea* have hitherto been regarded as a separate subclass, differing from all the other Echinids (*Euechinoidea*) in having more than two series or (*Bothriocidaris*) only one series of interambulacral plates and two or more ambu-

¹⁾ A review of the different classifications of the Echinoidea has been given by MEISSNER in Bronn's Classen u. Ordn. Echinodermen. p. 1321.

²⁾ The Echinometridæ, their affinities and systematic position. Proc. Zool. Soc. 1881. p. 410.

lateral plates. In Lankester's „Treatise on Zoology“ III (1900) GREGORY has made a most interesting attempt at a more natural classification. The Palæechinoids are no more regarded as a separate subclass equivalent to all other Echinids, but they are united with the regular Echinids and, together with the *Cidaridæ*, classed as *Regularia Endobranchiata*. I think this a very important step towards a natural classification, though I do not quite agree with GREGORY in the arrangement of the families. It seems to me rather bold to place the *Cidaridæ* and *Lepidocentridæ* in one order. But that the *Archæocidaridæ* are closely related to the *Cidaridæ* seems, indeed, very probable, the only important difference, as far as we know, being the pluriseriate arrangement of the interambulacral plates in the *Archæocidaridæ* — and this character even is not quite exclusive, there being four series of interambulacral plates in *Tetracidaris*, which can by no means be classed with the *Archæocidaridæ*. I think it right then to follow GREGORY in uniting the *Archæocidaridæ* and the *Cidaridæ* into one order, *Entobranchiata*¹⁾, against another order: *Ectobranchiata*, comprising the other regular Echinoidea, except, perhaps, some of the *Palæechinoidea*. GREGORY is scarcely right in assuming that none of the *Palæechinoidea* had outer gills; but as I have no very extensive knowledge (and only literary) of the Palæechinids I shall not enter into a more detailed discussion of this problem.

The family *Echinothuridæ* Wyv. Thomson is adopted by AGASSIZ in the „Challenger“-Echini, though it is pointed out that its difference from the *Diadematidæ* is very slight, „some of the species of Echinothuridæ here described show(ing) that some of the important characters upon which this family is distinguished from the *Diadematidæ* may become gradually obliterated“. In some Echinothurids „the lapping of the plates is reduced to a minimum, if it exists at all“, while on the other hand in *Astropyga* the lapping of the plates is very distinct, which genus therefore must be considered „a genus either belonging to the Echinothuridæ or at any rate possessing some of the most characteristic features of both the *Diadematidæ* and *Echinothuridæ*“. (Op. cit. p. 72.) These facts pointed out by AGASSIZ certainly show that the lapping of the plates is no exclusive character of the *Echinothuridæ*, but they do not at all show the family to be untenable. The structure of the ambulacra and the continuation of the ambulacral plates on the buccal membrane are characters so distinct that there can be no doubt at all of the *Echinothuridæ* forming a very distinct family. Also the structure of the actinal spines which end in a distinct hoof or a thick bag of skin seems to be a very exclusive character; it is to be remembered, however, that we do not know, how the actinal spines of *Kamptosoma* terminate. With regard to pedicellariæ and spicules no characters of importance can be pointed out as distinguishing the *Echinothuridæ* from the *Diadematidæ*. DUNCAN and LAMBERT (and recently MEISSNER) place the

¹⁾ The name *Holostomata* cannot be used, as also the Echinothurids are holostomatous.

Echinothuridæ as a suborder *Streptosomata* of the *Diadematoidea* against all the other families as another suborder *Stereosomata* (*Stereodermata*)¹⁾. POMEL goes even further, as he unites the *Echinothuridæ* with the *Cidaridæ* as *Holostomata* against all other regular Echinoids (the Palechinoids excepted) as *Glyphostomata*. But it is to be remembered that he did not know the occurrence of gills in the Echinothurids. If he had known that (and he might have known it, as LUDWIG's paper on *Asthenosoma varium* was published in 1880, POMEL's work in 1883), he would certainly have altered his classification. GREGORY goes the other way, making the Echinothurids only a family of his suborder *Diademina*. He finds the characters given for the suborder *Streptosomata* indistinctive. „In the Pedinid *Astropyga* and the Diademid *Helikodiadema* the test is more or less flexible. Both external and internal branchiæ are as well developed in *Diadema* as they are in *Phormosoma*. In those of the *Stereosomata* which have plates on the peristomal membrane these are always ambulacral“²⁾. It is very curious that GREGORY has been induced to make the latter assertion, which is as much erroneous as it is fundamental. In all the regular Echinids, except the Cidarids and Echinothurids, there are only five pairs of buccal ambulacral plates, provided with tube feet, which are mostly larger and a little different from the other tube feet (in a single instance, *Pleurichinus Döderleini* there are constantly only five unpaired buccal plates and tubefeet; see the description of this species below). Besides these buccal plates there may be more or less numerous plates in the buccal membrane, but these are always irregularly placed, and have nothing at all to do with either the ambulacral or interambulacral coronal plates; they are formed in the buccal membrane itself, the youngest ones being found nearest to the edge of the peristome, not detached from the test, and there are never found tubefeet on these plates. In the Echinothurids the plates covering the peristome are true ambulacral plates, all bearing tubefeet, and the first pair of tubefeet are not larger than or different from the following ones. In the Cidarids the same fact holds good, only here also the interambulacral plates continue over the peristome. — These fundamental facts have already been clearly pointed out by LUDWIG³⁾, who has, indeed, first placed the Echinothurids as a separate group against all the other regular Echinids above the Cidarids. — GREGORY further thinks he has found in the genus *Pedinothuria* a form intermediate between the Pedinids and the Echinothurids, showing the latter family to be „an offshoot from the Pedinidæ“ (Treatise on Zool. p. 310). This genus has perforate, crenulate tubercles, the pores are arranged biserially at the

¹⁾ W. KEEPING. Notes on the Paleozoic Echini. Quart. J. Geol. Soc. XXXII. 1876. p. 40. Under the section *Stereodermata* KEEPING includes both regular and irregular Echini (Endocyclica and Exocyclica Wright). The name can then scarcely be used in the meaning of DUNCAN and LAMBERT.

²⁾ On the affinities of the Echinothuridæ; and on *Pedinothuria* and *Helikodiadema*, two new genera of Echinoidea. Quart. Journ. Geol. Soc. LIII. 1897.

³⁾ Über *Asthenosoma varium* Grube und über ein neues Organ bei den Cidariden. Morph. Studien. II. p. 17. (1880.)

ambitus, triserially on the actinal side, and the buccal membrane is as in other Diadematids. The apical system is unknown, but as it was very large (its diameter about half that of the test) there can scarcely be any doubt that its structure was diadematoïd. It is then difficult to see how *Pedinothuria* can prove the Echinothurids to be an offshoot from the Pedinids, as it has evidently nothing to do with either of these families but must be referred to the *Pseudodiadematidæ* (or *Diadematidæ*). GREGORY has thus not produced any fact extinguishing the fundamental difference between the Echinothurids and the other regular Echinids, viz. the continuation on the peristome of the ambulacral plates.

Also NEUMAYER¹⁾ is inclined to think the Echinothurids have been derived from the Pedinids. It must be taken for granted, he argues, that the complicated structures of ambulacra are developed on account of the compression of the plates, „wenn die überzähligen Ambulacraltäfelchen nicht oder nur in ungenügender Zahl auf das Peristom übertreten können. Demgemäss kann auch die Herausbildung von complicierten Ambulacralbildungen nur bei Formen mit starrem Gehäuse stattfinden“. Accordingly the ancestors of the Echinothurids must have had a hard test. Among the Palæechinids the genus *Palæechinus* has a hard test and a beginning of the complicated ambulacral structures. It is, however, difficult to understand how the Echinothurids could have developed from a form as *Palæechinus*, and no intermediate forms are known. It seems then necessary to derive them from the Diadematids, and here *Pelanechinus* is thought to be intermediate between *Hemipedinina* and the Echinothurids. — *Pelanechinus*, however, has now been proved by GROOM to be a true Echinothurid, even a very specialized form, and thus it can prove nothing of the ancestry of the Echinothurids any more than *Pedinothuria* can.

On a priori grounds it seems, indeed, rather absurd to derive the Echinothurids from the most specialized group of Diadematids, the *Pedinidæ*. It is the most natural thing to look out for the ancestors of the Echinothurids among the Palæechinids, and perhaps we may find them among the *Lepidocentridæ*. The genus *Lepidechinus* has been shown by JACKSON²⁾ to have the ambulacra, but not the interambulacra, continuing over the peristome, and the same probably will hold good for the other genera. The ambulacra are simple, consisting of two series of plates, whereas the interambulacra consist of several rows of imbricating plates. There is thus, in fact, only this one essential difference between *Lepidechinus* and the Echinothurids, viz. the structure of the interambulacra, which also obtains between *Archæocidaridæ* and *Cidaridæ*. I think then, it will be natural to unite the *Lepidocentridæ* and the *Echinothuridæ* into one suborder: *Streptosomata*.

The character of the multiple series of plates in the interambulacra (and ambulacra) seems thus to be less important than has been hitherto commonly thought.

¹⁾ Stämme des Thierreichs I. 1889. — Über Palæechinus, Typhlechinus und die Echinothuriden. N. Jahrb. f. Mineral. Geol. u. Pal. 1890. I. p. 84.

²⁾ Studies of Palæechinoidea. Bull. Geol. Soc. America. VII. 1896.

Forms like *Tetracidaris* and *Sperosoma* also show this character to be less exclusive. — It is interesting to note that in both Cidarids and Echinothurids we thus know a form with pluriseriate plates.

JACKSON finds an important stage of development in the condition with only one interambulacral plate and two ambulacral plates, as in *Bothriocidaris*; he names it the „Protechinus“-stage. It is found, indeed in all Echini. For the Echinothurids it has not hitherto been indicated to exist. I can, however, assert that it is really found; it is seen very distinctly in young *Phormosoma placenta*. I give here a figure of this stage (Fig. 4).

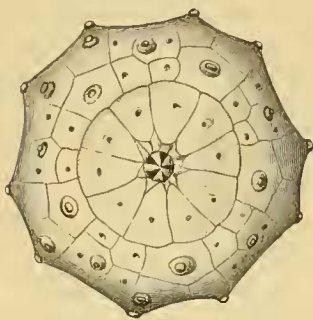


Fig. 4. Actinal side of a young *Phormosoma placenta* (3 mm. diameter) in the „Protechinus“-stage.

It now remains to group the families of the *Stereosomata*. The characters upon which such an arrangement must be undertaken are: the structure of the ambulacra — diadematoid or echinoid — and the structure of the tubercles — perforate or imperforate — (the crenulation is evidently of much less value). Finally the structure of the teeth — keeled or unkeeled — is evidently a very important character, though it has hitherto received very little attention. Other more important characters I do not find; but when we group the families according to these three characters an arrangement results which seems to answer fairly well to the natural relations of the different families. — Unfortunately the structure of the ambulacra and, especially, of the teeth is unknown in a great number of the fossil forms.

But it is likely that these structures will be known by and by, the teeth being not so very seldom preserved in the fossil Echini. For the present we must mainly make our conclusions from the recent forms.

An examination of the different families with regard to these features then gives the following result. Diadematoid ambulacra, perforate tubercles and unkeeled teeth are found in the fam. *Diadematidae*, *Micropygidae* and *Pedinidae*¹⁾; the *Aspidodiadematidae* certainly belong to the same group, their simple ambulacra evidently representing only a primary stage of the diadematoid ambulacra (in *Aspidodiadema* the ambulacral plates with the large tubercles are indeed compound after the diadematoid type). That the *Pseudodiadematidae* belong to the same group I think nobody will doubt, even though the teeth are unknown. Further the *Hemi-*

¹⁾ When seeking information in „Rev. of Ech.“ of the structure of the teeth in *Ctenopodina*, I found the following information: p. 292 „the teeth resemble those of *Arbacia*“; of the *Arbaciidae* it is said p. 263: „teeth like those of *Diadematidae* and *Cidaridae*“ (unkeeled); p. 399: „the teeth are shaped as in the *Diadematidae* and *Echinidae* proper“ (keeled and unkeeled); p. 688 the teeth are said to be „keeled in the middle“. — It is rather difficult to find from these indications the real fact that in *Arbaciidae* the teeth are keeled, in *Ctenopodina* they are unkeeled.

cidaridæ certainly have to be referred to this group also, since they likewise have unkeeled teeth, diadematoid ambulacra and perforate tubercles.

The *Saleniidæ*, *Arbaciidæ* and *Phymosomatidæ* agree in having imperforate tubercles and keeled teeth. The *Saleniidæ* have simple ambulacra; in the two other families the structure is diadematoid. These three families are evidently related, especially the *Arbaciidæ* and *Phymosomatidæ*. The *Saleniidæ* on account of their other peculiarities (apical system, spines of cidaroid structure) form a special group, but it is perhaps not unreasonable to see their nearest allies in the *Arbaciidæ*. If the fam. *Stomechinidæ* Pomel be rightly maintained, it will probably have its place near the *Arbaciidæ*.

The rest of the families of regular Echinids all agree in having echinoid ambulacra, imperforate tubercles and keeled teeth. These families then evidently form one group, as has, indeed, been commonly accepted.

The result of the grouping of the families after the structure of ambulacra, tubercles and teeth is thus seen in no way to violate evident natural relations. All the diadematoid genera remain in one group and all echinoid genera likewise remain together. It can thus scarcely be said to be an unnatural classification. But then the uniting of *Arbaciidæ* and *Phymosomatidæ* (and *Stomechinidæ*) must in all probability also be the natural grouping of these families, which have been so differently placed in the previous systems; likewise the referring of the *Hemicidaridæ* to the group of the Diadematids must certainly be correct. My system of the regular Echinids then looks as follows, the Palæechinids being partly left out of consideration:

Order 1. Entobranchiata.

Suborder. Cidaroida. Both ambulacral and interambulacral plates continuing over the peristome.

Fam. 1. Archæocidaridæ.

— 2. Cidaridæ.

Order 2. Ectobranchiata.

Suborder 1. Streptosomata. Ambulacral plates covering the peristome; no large „buccal“ plates, the first pair of tube-feet not developed as larger „buccal“ tube-feet.

Fam. 1. Lepidocentridæ.

— 2. Echinothuridæ.

Suborder 2. Stereosomata. Only 5 pairs of ambulacral plates, the „buccal“ plates, on the peristome, provided with tube-feet mostly larger than those of the test.

Tribus 1. Diademina. Ambulacra diadematoid; tubercles perforate; teeth unkeeled.

- Fam. 1. Aspidodiadematidæ.
 — 2. Diadematidæ.
 — 3. (?) Pseudodiadematidæ.
 — 4. Micropygidæ.
 — 5. Pedinidæ.
 — 6. Hemicidaridæ.
- Tribus 2. Salenina. Ambulacra simple; tubercles imperforate; teeth keeled.
 Fam. 1. Saleniidæ.
- Tribus 3. Phymosomina. Ambulacra diadematoid; tubercles imperforate; teeth keeled.
 Fam. 1. Arbaciidæ.
 — 2. Phymosomatidæ.
 — 3. (?) Stomechinidæ.
- Tribus 4. Echinina. Ambulacra echinoid; tubercles imperforate; teeth keeled.
 Fam. 1. Stomopneustidæ.
 — 2. Temnopleuridæ.
 Subfam. Temnechininæ.
 — Temnopleurinæ.
- Fam. 3. Echinidæ.
 Subfam. Parechininæ.
 — Echininæ.
- Fam. 4. Toxopneustidæ.
 Subfam. Schizechininæ.
 — Strongylocentrotinæ.
 — Parasaleninæ.
- Fam. 5. Echinometridæ.

Fam. Temnopleuridæ.

It is a very surprising fact that the pedicellariæ of the Temnopleurids prove to be only of subordinate value for classification. In the allied families *Echinidæ*, *Toxopneustidæ* and *Echinometridæ* they afford excellent characters for both species, genera and families, and also in the *Cidaridæ*, *Echinothuridæ* and *Diadematidæ* they afford very important systematic characters. In the Temnopleurids they mostly give only specific characters. In the larger genera, e. g. *Salmacis*, *Temnopleurus*, the globiferous pedicellariæ assume the forms occurring both in the *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*; in some species, e. g. *Salmacis bicolor*, they even occur in the same specimen in both the two forms which distinguish the families *Toxopneustidæ* and *Echinometridæ*. This very curious fact, of

course, does not alter the classificatory value of the pedicellariæ in the other regular Echinids; but we are forced to seek the generic characters of the Temnopleurids in the structure of the test. (The spicules do not yield such characters either; they are, with the single exception of *Temnopleurus Reevesii*, simply bihamate). Now, fortunately, the Temnopleurids afford many very characteristic features in the test, and as these have been very well studied by the previous authors on this subject, the classification of these forms is very well founded, and I have almost nothing to alter with regard to the genera. As for the species the pedicellariæ often afford excellent characters, and thus, naturally, a close examination of these structures makes some rearrangement of the species necessary.

All the usual four kinds of pedicellariæ occur in the Temnopleurids¹⁾. The tridentate ones have not been found in all the species, thus f. i. in several of the *Pleurechinus*-species. They do not vary much in form, but afford, however, good specific characters in a few instances (the *Salmacis*-species). The globiferous pedicellariæ are always without neck, and they have always (? *Amblypneustes grossularia*) two quite separate glands on each valve; the stalk is composed of long fibres as in the *Echinidæ*. As is said above, they occur in all the forms found in the *Echinidæ*, *Toxopneustidæ* and *Echinometridæ*. The primitive form known from *Parerchinus* and *Loxechinus* is found among the Temnopleurids only in *Hypsiechinus*, which is evidently the most primitive of all the *Temnopleuridæ*, as indicated also by its triradiate spicules. The globiferous pedicellariæ of *Mespitia* (Pl. VII. Fig. 16, 22) remind one somewhat of this form, but they are evidently rather modified. — The form characteristic of *Echinus* is found in some species of *Salmacis* and *Temnopleurus*, (*Salm. spheroides*, *dussumieri*, *Temnopl. toreumaticus*); the form without lateral teeth characteristic of the *Toxopneustidæ*, is found in *Salm. virgulata* and *bicolor*, *Pleurechinus variegatus* etc. The most common form, however, is that with one unpaired lateral tooth, the Echinometrid-form; it occurs in *Salm. bicolor* and *belli* (together with the form without lateral teeth), *Pleurechinus Döderleini*, *Amblypneustes* etc. The ophicephalous and triphyllous pedicellariæ do not present any marked peculiarities: the latter are never serrate in the outer edge, except in *Prionechinus* and *Trigonocidaris*. The sphaeridiæ do not present any peculiar features. — The spicules are bihamate, with the exception only of *Hypsiechinus* and *Temnopleurus Reevesii*, in which latter species they are bowshaped, the ends not being bent inwards. They are mostly very scarce and very delicate.

Specific characters of importance are also found in the spines, especially in the form of the point. It may be knoblike, smooth, or it may form a long central

¹⁾ DUNCAN in his paper „On some Points in the Anatomy of the Temnopleuridæ“ (Ann. N. Hist. 6. Ser. 1. 1888) gives a description of the pedicellariæ of *Temnopleurus* (p. 128) which is very confused. His „common tridactyle pedicellariæ“ are the globiferous ones, and they have not „often“ long, soft necks. „The globiferæ“ are ophicephalous and the figure given of a „triphylta or ophicephalous“ pedicellaria looks more like a small ophicephalous one.

thorn surrounded by smaller ones etc. They are especially of importance in the genera *Pleurechinus* and *Amblypneustes*.

The buccal membrane is mostly quite naked, with the exception, of course, of the buccal plates; only in *Trigonocidaris*, *Prionechinus* and *Hypsiechinus* it is covered with large plates. There are some small irregular plates just round the mouth, otherwise no plates or only a few, but mostly numerous bihamate spicules; where such plates are found outside the buccal plates, they are mostly placed opposite to the gills, carrying some pedicellariæ. Otherwise pedicellariæ are very scarce or quite wanting on the buccal plates; neither do spines occur thereon. A very curious feature is found in the new species of *Pleurechinus*, *Pl. Döderleini*, described below, there being only five buccal plates and five buccal tube-feet. It reminds one of *Prionechinus* and *Hypsiechinus*, which have likewise only five buccal tube-feet (but ten buccal plates) in the young stages; but in *Pl. Döderleini* this condition is permanent.

In the collections brought home by the Siam-Expedition the Temnopleurids are very well represented, viz. by the species: *Temnopleurus toreumaticus*, *Salmacis sphaeroides*, f. *typica*, *S. bicolor*, var. *rarisipina*, *S. virgulata*, *S. dussumieri*, *Pleurechinus Döderleini* n. sp. and *Pl. siamensis* n. sp. Further specimens of *Temnopleurus Reevesii* are found in the Museum of Copenhagen, from the Gulf of Siam (SALMIN).

6. *Temnopleurus toreumaticus* (Klein).

Pl. VI. Figs. 8, 14, 22, 49. Pl. VII. Figs. 3, 28.

Cidaris loreumatica. KLEIN. 1734. Naturalis dispositio Echinodermatum. p. 17. Pl. X. fig. E.

Temnopleurus toreumaticus. L. AGASSIZ & DESOR. 1846. Catalogue rais. des Éch. p. 360 (56).

Reynaudi

Toreumatica granulosa GRAY. 1855. An arrangement of the Families of Echinidæ, with descriptions of some new Genera and Species. Proc. Zool. Soc. 1855. p. 39.

Temnopleurus toreumaticus. A. AGASSIZ. 1872. Rev. of Echini. p. 166, 463. Pl. VIII. a. fig. 4-5.

— *granulosus*. BELL. 1880. On some genera and species of the Temnopleuridæ. Proc. Zool. Soc. 1880. p. 424-25.

— *toreumaticus*. DUNCAN. 1881. On some points in the Morphology of the test of the Temnopleuridæ. J. Linn. Soc. XVI. p. 350. Pl. VIII. figs. 10-14.

— — DÖDERLEIN. 1885. Seeigel v. Japan u. den Liu-Kiu-Inseln. p. 15.

— — IVES. 1891. Echinoderms and Arthropods from Japan. Proc. Acad. Nat. Sc. Philadelphia. 1891. p. 214.

— — BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 280.

Non: *Temnopleurus Reynaudi*. A. AGASSIZ. Rev. of Echini (= *Reevesii* Gray).

— — *toreumaticus* SLADEN. 1878. On the Asteroidea and Echinoidea of the Korean Seas. J. Linn. Soc. XIV. p. 438. (= *Pleurechinus variegatus* Mrtsn.).

— — — BELL. 1884. Echinodermata „Alert“-Exped. p. 119.

— — — DE MEIJERE. 1904. Siboga-Echinoidea. p. 80.

This very well known species has been excellently described by AGASSIZ and DÖDERLEIN. Only the pedicellariæ and spicules need yet be mentioned, the description of the pedicellariæ given by DUNCAN being far too inaccurate, as pointed out above. The globiferous pedicellariæ (Pl. VI. Fig. 8, 14) have one little, but distinct lateral tooth on each side of the rather elongate blade, which is closed, with the exception of a small elongate opening just below the lateral teeth; sometimes, however, one of the lateral teeth may be wanting, or the one may be placed farther down than the other. The outer corners of the basal part are somewhat produced. The tridentate pedicellariæ (Pl. VI. Fig. 49, Pl. VII, Fig. 3) have long and narrow valves, a little curved, wide apart, joining only at the point. The edge is a little serrate or sometimes quite smooth, except at the point, which has a few larger serrations. No meshwork in the blade; the apophysis has some coarse serrations in the edge. They are mostly small, but may reach a size of 1 mm. (head). In the ophicephalous pedicellariæ (Pl. VI. Fig. 22) the valves are rather elongate, otherwise they do not present marked features, and the same holds good for the triphyllous ones. (Pl. VII. Fig. 28). — The spicules are bihamate and very few in number. In the buccal membrane there are some irregular plates inside the buccal plates; outside these the membrane is almost bare, only with a few plates opposite to the gills; very few bihamate spicules occur in the buccal membrane. In the walls of the intestine and genital organs there are some few bihamate spicules, only now and then a spot may be found, where the spicules are more crowded.

Several specimens were taken in the fishing-nets of the natives at Koh Kong, (4—5 fathoms); also some small specimens were taken at Koh Kahdat, 10 faths., between Koh Rin and Cliff Rock, 15 faths., and N.W. of Koh si Chang, c. 10 faths. By the Skeat-Expedition it was taken at Pulo Bidang (1 specimen).

Quite small specimens (c. 5—6 mm. in diameter) are not easily distinguished from equally sized specimens of *Salmacis sphaeroides*, the pits of the test being as yet rather alike in size. However, the spines are proportionally much longer in *T. toreumaticus* (almost as long as the diameter of the test in *toreumaticus*, scarcely half that length in *S. sphaeroides*). The colour of the spines is a little different, more greenish in *toreumaticus*, reddish or whitish in *sphaeroides* (both are ringed); the pedicellariæ present only quite insignificant differences.

Temnopleurus Reynaudi L. Agass. is, as might already be supposed from the original diagnosis (Cat. rais. p. 56), synonymous with *T. toreumaticus*. Dr. GRAVIER has most kindly sent me the type-specimens for examination, so that I am able to say this with full certainty. What AGASSIZ describes under the name of *T. Reynaudi* in „Rev. of. Ech.“ is not this species but *Temnopl. Reevesii* (Gray). (See below.)

Temnopleurus granulatus (Gray) is made synonymous with *T. Reevesii* („*T. Reynaudi*“) by AGASSIZ (Rev. of Ech. p. 166). BELL (Op. cit.) maintains it as a distinct species. After having examined the type-specimens of GRAY in the British

Museum I must quite agree with BELL that they have nothing to do with *T. Reevesii*, but on the other hand I do not find a single character by which to distinguish *granulosus* with certainty from *toreumaticus*. BELL does not point out any character distinguishing it from *toreumaticus*, he only remarks that the sutural furrows are not so deep nor so wide as in that species; but this is a feature much too variable to be relied upon for sole specific character. Accordingly I must regard *T. granulosus* as a synonym of *T. toreumaticus*. — The specimens of „*T. granulosus*“ mentioned by BELL¹⁾ from Port Denison, Queensland, are partly *Salmacis Alexandri*, partly another *Salmacis* (probably *S. sphaeroides*, var. *pyramidata*); only a single small specimen is probably *T. toreumaticus*.

In the „Alert“-Echinodermata (p. 119) BELL mentions a specimen of *Temnopl. toreumaticus* from Port Denison, which „has all the spines which are preserved on it perfectly white, without any bands whatever“. I have examined this specimen in the British Museum and can thus assert that it is not *T. toreumaticus*; its globiferous pedicellariæ have no lateral teeth. To which species and genus it belongs I cannot say, having not examined it sufficiently for that purpose.

The specimen described by SLADEN in his paper on the Asteroidea and Echinoidea of the Korean Seas²⁾ as a young *Temnopl. toreumaticus* is a *Plenrechinus* of the species described below as *Plenrech. variegatus*. (The specimen was examined in the British Museum). Finally the specimen referred by DE MEIJERE to *Temnopl. toreumaticus* (Op. cit.) is not that species either. The globiferous pedicellariæ have no lateral teeth, and the spines are yellowish-green with red base; from these two characters it might be supposed to be *Salmacis Alexandri*³⁾. „Nach anderen Autoren (DÖDERLEIN, BEDFORD) kommen auch Exemplare mit mehr oder weniger geringelten Stacheln vor“ says DE MEIJERE (Op. cit. p. 81). All the specimens I have seen of *T. toreumaticus* have ringed spines, though sometimes rather indistinctly, when the spines are very dark coloured, and I am not aware that specimens with not-ringed spines have been recorded, except those wrongly referred to *toreumaticus* by BELL and DE MEIJERE. On the contrary ringed spines do not occur in the other species of *Temnopleurus*; accordingly the ringed spines form one of the specific characters of *toreumaticus*, and the assertion that ringed spines do „also“ occur in this species thus sounds rather curious.

IVES (Op. cit.) regards *Temnopl. Hardwickii* (Gray) as synonymous with *toreumaticus*, having found specimens intermediate between these two species as defined by AGASSIZ. „One specimen having rather deep pits, has the ocular and genital plates covered with prominent tubercles, and other specimens show the

¹⁾ Echinodermata. „Alert“-Exped. p. 119.

²⁾ Journ. Linn. Soc. Zoology XIV. 1878. p. 438.

³⁾ After the manuscript was finished, DE MEIJERE has kindly lent me the specimen for examination. It is *S. virgulata* var. *Alexandri* or perhaps a new variety. The test is white; no tridentate pedicellariæ are found on the specimen.

passage from the deep rectangular pits to the bevelled grooves of the ambulacral and interambulacral regions". It is quite true that forms intermediate in the structure of the test between *toreumaticus* and *Hardwickii* may be found (I have seen such forms only among Japanese specimens); however, *T. Hardwickii* must be maintained as a distinct species¹). An examination of the pedicellariæ shows some additional good specific characters. The globiferous pedicellariæ (Pl. VI, Fig. 34, Pl. VII, Fig. 21) have no distinct lateral teeth, only a rounded knob on each side below the endtooth. The outer corners of the basal part are very sharp. (The figure of a „prong of open-headed, long-stemmed interambulacral pedicellaria“ given by AGASSIZ in „Rev. of Ech.“ Pl. XXV. 2, represents a valve of a globiferous pedicellaria, where the endtooth has been broken off, seen from the outer side). Tridentate pedicellariæ I have not been able to find on any of the specimens examined by me, among which are two large, beautifully preserved specimens from the Berlin-Museum. The ophicephalous pedicellariæ (Pl. VI. Fig. 32) are shorter and broader than in *toreumaticus*, and the sinuations of the edge are small and indistinct. The triphyllous pedicellariæ are alike in the two species, neither is there any difference as regards the spicules and their occurrence in the tubefeet, buccal membrane and internal organs.

The characters thus found in the pedicellariæ added to those previously known, viz. the raised apical system, the bevelling of the pits (in larger specimens) and the colour of the spines (dark at the base, not ringed²)), certainly prove *T. Hardwickii* to be a distinct species. — POMEL (Op. cit. p. 87) goes to the opposite extreme of what has been maintained by IVES, holding *T. Hardwickii* to be a distinct genus, for which the old name *Temnotrema* Ag. is used. If that were right the older name *Toreumatica* Gray (under which *T. Hardwickii* is named as first species) would have to be used. But there is evidently no reason at all for making a separate genus of this species; it is merely a distinct, easily recognizable species of the genus *Temnopleurus*.

The (supposed) original specimens of *T. Hardwickii* (in the British Museum) are two naked tests which are, indeed, more like *toreumaticus* than *Hardwickii* as now understood. The pits are not much bevelled, the apical area not much elevated; the few primary spines remaining are greenish, not dark at the base; they are all broken, so it cannot be seen if they were ringed. It is thus rather doubtful if they are really the species now named *Hardwickii*, but as they are not suffi-

¹) MEISSNER (Die von Herrn Marine-Stabsarzt Dr. Sander heimgebrachten Seeigel. Sitz. ber. Ges. Naturf. Fr. Berlin. 1892. p. 183) also maintains *T. Hardwickii* as a distinct species against IVES, without giving his reasons for it, however.

²) *Temnotrema sculpta* A. Ag., which is referred to *T. Hardwickii* as synonym by AGASSIZ (Rev. of Ech.) is described as having „spines ringed with white and violet“; thus it certainly cannot be synonymous with that species. It needs a renewed examination.

ciently well preserved for stating beyond doubt to which species they belong, it would be unreasonable to alter the familiar name of *Temnopl. Hardwickii*.

The specimens mentioned by AGASSIZ in the Challenger-Echini p. 107 under *T. Hardwickii* are only partly that species. I have examined them in the British Museum and find them to be as follows:

Kobi, Japan. — 5 beautiful specimens of *T. toreumaticus*, recalling, however, in the development of their pits *T. Hardwickii*.

Arafura Sea. — A very young specimen, probably of *T. toreumaticus*; the spines are ringed, not dark at the base.

St. 192. — One specimen, representing a new species of the genus *Opechinus* (described below as *O. spectabilis*).

Off Yokohama. — 5 beautiful specimens of *T. Hardwickii*.

I may further remark that the two small specimens from lat. 32° 49' N., long. 128° 54' E. mentioned by SLADEN in the above cited paper on the Asteroids and Echinoids from the Korean Seas as young *T. Hardwickii* (p. 436) are *Pleurechinus variegatus* (see below) or a very nearly related species.

7. *Temnopleurus Reevesii* (Gray).

Pl. VI. Figs. 3, 10, 12. Pl. VII. Fig. 37.

Toreumatica Reevesii. GRAY. 1855. An arrangement of the Families of Echinidæ etc. Proc. Zool. Soc. 1855. p. 39.

Temnopleurus Reynaudi. AGASSIZ. 1872. Revision of Echini. p. 166, 161. Pl. VIII. 22–24, VIII. a. 6–7.

— — SLADEN 1878. On the Asteroidea and Echinoidea of the Korean Seas. J. Linn. Soc. XIV. p. 437.

— — BELL. 1880. On some genera and species of the Temnopleuridæ. Proc. Zool. Soc. 1880. p. 424.

— — DÖDERLEIN. 1885. Seeigel von Japan u. den Liu-Kiu-Inseln. p. 19.

— — DE MEJERE. 1904. Siboga-Echinoidea. p. 81. Pl. XVI. Fig. 270, Pl. XVII. Fig. 271.

Non: *Temnopleurus Reynaudi*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Éch. p. 56.

— — — BELL. 1894. Echinoderms of Macclesfield Bank. Proc. Zool. Soc. p. 410.

— — — (?) BEDFORD. 1900. Echinoderms from Singapore and Malacca; p. 281.

The description of this easily recognizable species given by AGASSIZ is very good, so I need only add a few remarks, mainly on the pedicellariæ and spicules. — The globiferous pedicellariæ, as described and figured by DE MEJERE, have a long, fine lateral tooth on either side or sometimes only on the one side below the long and slender endtooth; they are generally placed at an unequal distance from the end-

tooth, that on the straight side farther down than that on the side with the terminal widening. The outer corners of the basal part are broadly rounded (Pl. VI. Figs. 3, 10). Tridentate pedicellariæ I have not found; the ophicephalous pedicellariæ are like those of *toreumaticus*, only less elongate and with less developed meshwork; the sinuations of the edge are rather deep (Pl. VI. Fig. 12). The triphyllous pedicellariæ do not present any peculiarities. The spicules (Pl. VII. Fig. 37) are very characteristic and unique among the Temnopleurids; they are biacerate, bowshaped, without branches. They occur in the head of the globiferous pedicellariæ, in the tubefeet, buccal membrane and gills. Common bihamate spicules may occur more or less numerous among the biacerate ones. Very few, bihamate, spicules are found in the walls of the intestine and genital organs.

The buccal membrane has rather few plates inside and none outside the buccal plates; the latter are placed one a little outside the other (in *toreumaticus* and *Hardwickii* they are placed at the same distance from the mouth). The spines are a little more coarsely spinous than in the two other species; this, however, is a very unimportant difference. Upon the whole the spines of the *Temnopleurus*-species are very smooth. It may also be remarked that the actinal primary spines are curved, in all three species.

This species was not taken by myself or by the „Skeat“-Expedition, but two specimens from the Gulf of Siam (SALMIN) are preserved in the Museum of Copenhagen.

AGASSIZ makes *T. Reevesii* Gray synonymous with *T. Reynaudi* L. Agass., and all the later authors follow him therein. As stated above (p. 59) this is wrong. As I had not remarked all the essential characters of the type-specimens of *T. Reynaudi* during my visit last summer in Paris, having not yet at that time studied the Temnopleurids more profoundly, I asked Dr. GRAVIER to send me, if possible, the specimens for a more close examination. With the greatest liberality, for which I beg him to take my best thanks, Dr. GRAVIER sent me the specimens (those from Ceylon (Reynaud); those from Malacca (Eydoux et Souleyet) cited in the „Catalogue raisonné“ p. 56 are no longer in the Paris Museum). I could thus directly compare them with the other species of *Temnopleurus*, and the result is that they prove to be identical with *toreumaticus*, as might, indeed, have been supposed from the diagnosis given in „Cat. rais.“ — The species described by A. AGASSIZ (Rev. of Ech.) is therefore not *T. Reynaudi*, but it completely agrees with *T. Reevesii* Gray, the type-specimens of which (two naked tests) present the characters pointed out by AGASSIZ as distinctive of „*T. Reynaudi*“: one ocular plate reaching the periproct, the pores placed at some distance from the edge of the ambulacral area etc. — The name *T. Reevesii* must then be revived for this species, and the name *T. Reynaudi* must be dropped as a synonym of *T. toreumaticus*.

In his paper „On the Echinoderms of Macclesfield Bank“ Prof. BELL mentions two specimens of „*T. Reynaudi*“ with rather long, creamy white spines, with

bands of red or with the free end red. Already from this colour of the spines it might be supposed not to be *T. Reevesii*, and the examination of the specimens shows them to be something quite different from that species; they belong to the genus *Gymnechinus* and must form a new species, which is described below as *Gymnechinus versicolor*. Otherwise *T. Reevesii* is really found on Macclesfield Bank. I have seen in the British Museum several specimens from that locality named *T. loreumaticus* (not mentioned in BELL's Report), which are really *T. Reevesii*.

The specimen mentioned by BEDFORD (Op. cit. p. 281) as *Temnopleurus Reynaudi*? I have also examined in the British Museum; it is *Salmacis dussumieri*. Of the specimens mentioned in the Challenger-Echini p. 107 as *Temnopl. Reynaudi* scarcely one is really *T. Reevesii*. The specimen from St. 166 is very small (4.5 mm. in diameter), without genital pores. There is a small red spot on the outer end of each genital plate; a large anal plate covers the whole anal area. This may perhaps be *T. Reevesii*, but it is not possible to say so without a very careful examination and comparison with undoubted young specimens of *Reevesii*. To which species the other specimens, from St. 192 and 219, belong I dare not say from the short examination of them I made during my visit in the British Museum last summer. I may only remark that they have large pits, distinct down to the peristome; no ocular plate reaches the periproct; the spicules are bihamate. These characters prove that the specimens are not *T. Reevesii*.

Only the three species of *Temnopleurus* mentioned here are known as yet. *T. japonicus* v. Martens is stated by AGASSIZ (Rev. of Ech. p. 166) to be synonymous with *T. Hardwickii*. — Dr. MEISSNER has kindly sent me the type-specimens (naked tests), and, indeed, the whole material of *Temnopleurus* preserved in the Berlin-Museum, for examination, so I have been able to compare them with the other species. As far as can be seen from the naked tests alone they are really identical with *T. Hardwickii*. Two other specimens from Japan, determined by v. MARTENS (1881) and DÖDERLEIN as *T. japonicus*, are *loreumaticus*.

Temnopleurus cavernosa Woods¹⁾ is seen from the figures and the description to be a *Pleurechinus*, and it can even scarcely be doubted that it is *Pl. bothryoides*, the only species known to grow to such a size as shown in these figures.

The three species of *Temnopleurus* may be distinguished thus:

1. Spicules biacerate (and bihamate); one ocular plate in contact with the periproct. A distinct anal plate is found, even in larger specimens. The pores are distant from the edge of the ambulacral area. Pits very small on the abactinal side, almost as in *Salmacis*. Spines not ringed. *T. Reevesii* (Gray).

Spicules bihamate only; no ocular plate in contact

¹⁾ I. E. TENISON-WOODS. On a young specimen of a *Temnopleurus*. Proc. Linn. Soc. N. S. Wales. V. 1880. p. 493—94. Pl. XV. Figs. 3—4.

with the periproct. No distinct anal plate in larger specimens. The pores are close to the edge of the area. Pits large on the abactinal side (sharp or bevelled)..... 2.

2. Globiferous pedicellariæ without distinct lateral teeth; ophicephalous pedicellariæ with the edge very little sinuated. Apical area raised; pits bevelled in larger specimens. Spines dark at the base, not ringed *T. Hardwickii* (Gray).

Globiferous pedicellariæ with 1—1 small, but distinct lateral teeth; ophicephalous pedicellariæ distinctly sinuate at the edge. Apical area not raised; pits (mostly) sharp, also in larger specimens. Spines ringed *T. loreumaticus* (Klein).

8. *Salmacis bicolor* Ag., var. *rarispina* (Ag.).

Pl. VI. Figs. 2, 4, 23, 26, 39, 40. Pl. VII. Fig. 1.

- Salmacis bicolor*. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Échinides. p. 55.
 — *rarispinus*. — Ibidem. —
 — *bicolor*. AGASSIZ. 1872. Rev. of Ech. p. 156, 471. Pl. VIII. a. Figs. 11—12.
 — *rarispina*. — Ibidem. p. 156, 475. Pl. VIII. b. Figs. 4—6.
 — *bicolor*. BELL. 1880. On some genera and species of Temnopleuridæ. p. 428.
 — *rarispina*. — Ibid. p. 429.
 — *bicolor*. BELL. 1882. Note on the Echinoderm Fauna of the Island of Ceylon, together with some observations on Heteractinism. Ann. Nat. Hist. 5. Ser. X. p. 219.
 — DE LORIOL. 1883. Catalogue rais. des Éch. de Maurice. p. 20.
 (?) — *globatrilæ*. LOVÉN. 1887. Echinoidea descr. by Linnæus. p. 72.
 — *bicolor*. DUNCAN & SLADEN. 1888. Echinoderms of the Mergui Archipel. Journ. Linn. Soc. XXI. p. 318.
 — *rarispina*. BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 283.
 — *bicolor*. DÖDERLEIN. 1902. Bericht über die von Herrn Prof. Semon bei Amboina u. Thursday Isl. gesammelten Echinoidea. p. 714. Taf. LXI. Fig. 6—10.
 — *rarispina*. DÖDERLEIN. 1902. Ibidem. p. 719. Taf. LXIV. Fig. 3—3 c.
 — — DE MEJERE. 1904. Siboga-Echinoidea. p. 83. Taf. V. Fig. 40.
 Non: *Salmacis rarispina*. DE LORIOL. 1893. Échinodermes de la baie d'Amboine. p. 370 (= *S. sphæroides* (L.)).
 — — — A. AGASSIZ. 1881. Challenger-Echinoidea. p. 113.

After the most excellent description of the structure of the test in the different *Salmacis*-species given by DÖDERLEIN it is unnecessary to discuss the subject here again. Only the pedicellariæ and a few other features need yet to be mentioned.

All the four common kinds of pedicellariæ are found — as in all the *Salmacis*-species. The globiferous pedicellariæ are of two different kinds, a large form without lateral teeth (Pl. VI. Fig. 26) and a small, delicate form with one, unpaired

lateral tooth (Pl. VI. Fig. 2). The large form, which has also been observed by DE MEIJERE, is almost exclusively found on the upper part of the test, where it is very conspicuous; the small form is also very numerous at the top of the test, but occurs more spread over the whole test. The tridentate pedicellariæ are rather small (ca. 0.8 mm. head); the blade is short and broad, the edge irregularly sinuate and finely serrate (Pl. VI. Figs. 39, 40. Pl. VII. Fig. 1). In the larger forms the valves join only in the outer part, in the smaller ones in almost their whole length, and in these the edge is almost quite straight; the larger ones have a well developed meshwork in the bottom of the blade. The ophicephalous (Pl. VI. Fig. 4) and the triphyllous pedicellariæ (Pl. VI. Fig. 23) do not present any marked peculiarities. — The spicules of the tube feet are bihamate and usually very few in number.

The buccal membrane contains numerous small, irregular, fenestrated plates inside the buccal plates; outside these there are some few thick plates opposite to the gills; sometimes there are numerous small plates over almost the whole membrane opposite to the interambulacra, whereas there are almost none opposite to the ambulacra. According to DE LORIO (Op. cit. p. 21) these plates „portent de soies d'une grande finesse“; these are certainly stalks of pedicellariæ, which occur (in spite of DE LORIO's assertion that he does not find pedicellariæ on the buccal membrane) on the large plates at the gills and on the buccal plates, but not on the other small plates, when such are developed. Bihamate spicules are not numerous in the buccal membrane; sometimes, however, small patches are found quite studded with spicules. The gills contain the usual irregular plates, but mostly in the lower part only; in the finer branches only bihamate spicules are found. — The walls of the intestine are provided with rather few bihamate spicules, whereas the stone-canal is quite studded with such spicules, interwoven with each other. The genital organs consist of a great many long, unbranched tubes, arranged round a long main stem; the latter and the lower part of the tubes are quite full of bihamate spicules, whereas the tubes are quite destitute of spicules.

Many specimens of different sizes of this most beautiful sea-urchin were taken at Koh Kram, 20—30 fathoms; also some specimens at Koh Chuen, 30 faths., and between Koh Kahdat and Koh Kut, 8—10 fathoms, all on hard bottom (sand, shells, stones). A specimen of only 2.5 mm. in diameter is already quite typical, with both kinds of globiferous pedicellariæ developed. One specimen is abnormal and deformed, one of the ambulacra reaching only halfway to the apical system.

Several of the specimens are infested with a small parasitic Gastropod, probably an Eulimid. Further I observed on several of them a little crab, which devours the spines (probably the museles only), pedicellariæ and tube feet, quite cleaning the test; it mostly follows one area from the top downwards. Where it has been, one may find young stages of pedicellariæ in enormous numbers, quite covering the test; also young spines may be found in such places. If the tube feet are regenerated, I cannot ascertain beyond doubt, but it seems so.

It has not hitherto been doubted that *Salm. bicolor* and *rarisipina* were two good species. Especially in DÖDERLEIN's most excellent work a full description is given of both of them, and the distinctive features are pointed out. *S. rarisipina* is distinguished from *S. bicolor* „durch die kleinen, sehr weit von einander entfernten Hauptwarzen der Apicalseite, durch die auffallend flache Unterseite und das kleine Buccalfeld, durch die sehr spärliche Warzenbildung, welche die Oberfläche auffallend nackt erscheinen lässt, sowie durch die rautenförmigen Zeichnungen auf der Schale“. (Op. cit. p. 721.) According to the description of the species given by DÖDERLEIN there is, however, a great variation in all these features; only in the character of the flat actinal side in *S. rarisipina* no variation is mentioned, but as DÖDERLEIN had only two specimens of *rarisipina* for examination, much stress can-

Locality.	Salmacis bicolor, typica.			Locality.	Salmacis bicolor, var. rarisipina.		
	Diameter.	Number of Ambulacral plates.	Number of l.-ambulacral plates.		Diameter.	Number of Ambulacral plates.	Number of l.-ambulacral plates.
Mauritius.	37 mm.	31	24	Siam.	36 mm.	30	26
Ceylon.	40 —	40	32	—	40 —	32	28
				—	42 —	31	26
				—	43 —	34	29
				—	44 —	36	30
Mauritius.	45 —	35	28	—	46 —	36	28
—	46 —	34	26	Zanzibar.	46 —	36	27
—	50 —	41	29	Siam.	50 —	36	30
				—	51 —	36	31
				—	51 —	35	28
				—	53 —	37	30
				—	55 —	41	32
?	56.5 —	48	35	—	55 —	38	33
Ceylon.	62 —	49	37	—	56 —	36	29

not be laid on this fact — and from my rich material it is seen that no reliable distinction can be found herein either. Also the height of the test is rather variable. In a letter to me DÖDERLEIN has further pointed out that the number of coronal plates is distinctly smaller in *rarisipina* than in *bicolor*. This will not always hold good either. When comparing the measurements of *S. bicolor* cited above from DÖDERLEIN (p. 720) with the measurements of my Siamese specimens, it will be seen that the specimens from Mauritius agree with the siamese form in the number of the coronal plates. There are then only left the two specimens from Ceylon and the one of unknown locality. Among the Siamese specimens there are none of 62 mm. diameter, so that only the specimens of 40 and of 56.5 mm. can be directly compared with specimens of *rarisipina*. We have then in a specimen of 40 mm.: 40 ambulacral and

32 interambulacral plates in *bicolor*, 32 ambulacral and 28 interambulacral plates in *rarispina*; in a specimen of 56 mm.: 48 ambulacral and 35 interambulacral plates in *bicolor*, 36 ambulacral and 29 interambulacral plates in *rarispina*, a very conspicuous difference. Now the material of *bicolor* examined is very small, and it may safely be supposed that a rather large amount of variation will occur also here. But the examinations made tend to show that the Ceylon-form of *bicolor* has on an average more coronal plates than those from Mauritius and the Siamese specimens of *rarispina*. Other distinctive characters do not seem to occur. Pedicellariæ, spicules and structure of spines are quite alike; as regards the colour of the spines it may be said that the light rings are generally broader in *rarispina* than in *bicolor*, but it is no constant feature. Neither can any character be taken from the angular pores; they vary very much, may be very distinct or almost quite obliterated in specimens of the same size. Thus I think it an inevitable conclusion that *Salmacis bicolor* and *rarispina* are indeed only one species, of which may be distinguished a forma *typica*, with numerous coronal plates, as yet known only from Ceylon, and a var. *rarispina*, with less numerous coronal plates, known from Siam, Mauritius and Zanzibar.

It may be especially remarked that I have examined the type specimens of both *bicolor* and *rarispina* in the Paris-Museum, also with regard to pedicellariæ. Furthermore Dr. GRAVIER has been so very kind as to send me the type specimen of *rarispina* for direct comparison with my Siamese specimens. I can thus say with absolute certainty that they are really *S. rarispina*. The question of these two „species“ I hope thus to have definitely settled.

The *Salmacis rarispina* of DE LORIOI from Amboina is, indeed, *Salm. sphaeroides*, as supposed by DÖDERLEIN. Through the kindness of Prof. BEDOT I have had the specimen sent for examination. The specimens mentioned by KOEHLER (Cat. rais. Éch. de la Sonde. p. 413) will then probably also be *sphaeroides*, as they are said to be identical with DE LORIOI's specimen. The *S. globalrix* of LOVÉN can scarcely be anything but *S. bicolor*. The expression „spinæ basi rubræ“ does not agree with any other *Salmacis*-species. — The *Salm. bicolor* named by BELL in the „Alert“-Echinodermata (p. 118) is *S. belli* Döderl. — Of the specimens named in the „Challenger“-Ech. (p. 113) the *S. rarispina* from St. 188 is *S. belli*, those from St. 186 (2 small specimens) are, the one *S. dussumieri*, the other perhaps *S. belli* (no globiferous pedicellariæ found), at any case not *rarispina*. The specimens from St. 203 I have not seen. The *S. bicolor* from Zamboangan is really that species.

9. *Salmacis virgulata* Agass. forma *typica*.

Pl. VI. Figs. 7, 18, 46, 47. Pl. VII. Fig. 40.

Salmacis virgulatus. L. AGASSIZ & DESOR. 1846. Catalogue raisonné des Échinides p. 359 (55).

— *conica*. V. MARTENS. 1866. Ostasiatische Echinodermen. Archiv f. Naturgesch. 1866. p. 159.

- Salmacis Alexandri*. DÖDERLEIN. 1888. Echinod. von Ceylon. Zool. Jahrb. Syst. III. p. 836. Tab. 32.7. 33.10.
 — *sulcata*. DUNCAN & SLADEN. 1888. On the Echinoidea of the Mergui Archipelago. Journ. Linn. Soc. Zool. XXI. p. 317.
 — — SLUITER. 1889. Evertibraten Sammlung Batavia. Natuurk. Tijdschr. Nederl. Indie. 48. p. 292.
 — — BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 281. Pl. XXII. Fig. 3.
 — *virgulata, typica*. DÖDERLEIN. 1902. Echinoidea v. Amboina u. Thursday Isl. (Semon). p. 712. Taf. LXII. Fig. 2.
 — DE MEJERE. 1904. Siboga-Echinoidea. p. 83. Taf. XVII. Fig. 273.

The type specimen of this species I have also examined in the Paris-Museum, and as I have found both pedicellariæ and spines on it, I can positively assert that DÖDERLEIN's interpretation of this species is the right one. The characters of the test have been so well made out by DÖDERLEIN that nothing need be added. Only the pedicellariæ are insufficiently known.

The globiferous pedicellariæ (Pl. VI. Fig. 18) occur only in one, large form with rather elongated blade without lateral teeth; DE MEJERE has first mentioned and figured this form of pedicellariæ in this species. He mentions one „welche merkwürdiger Weise am Ende aller Klappen abgestutzt erschien, ohne dass von einem einfachen Abbrechen der Spitze die Rede war“. That must certainly be a not yet fully developed pedicellaria; the endtooth is formed at last, as I have seen beyond doubt in the different stages of development, which may rather easily be found. The tridentate pedicellariæ (Pl. VI. Fig. 7, 46, 47) are rather small (ca. 0.6 mm., head), the valves short, joining only at the point, the blade is narrow, with a few serrations in the edge; the outer edge, where the valves join, forms an obtuse angle with the side edge. The basal part of the valve is very large in proportion to the blade; sometimes there are four valves. The ophicephalous and triphyllous pedicellariæ without remarkable features, the meshwork in the blade of the former being, however, less developed than in *S. bicolor*, and the form a little more elongate (Pl. VII. Fig. 40).

The spicules of the tubefeet are very variable in number, sometimes almost none at all, sometimes a great number occurring, especially close under the sucking disk. Also in the globiferous pedicellariæ spicules may occur, as seen by DE MEJERE. In the buccal membrane there are numerous small plates inside the buccal plates; outside these a few rounded plates may be found in larger specimens. Bihamate spicules are not numerous in the buccal membrane. The gills as in *bicolor*. The intestine and genital organs, even the stone canal, almost without a single spicule. The genital organs of the common structure, a close aggregation of very irregular, branched tubes.

Numerous small specimens from between Koh Rin and Cliff Rock, 15 faths.; 1 large specimen from Koh Kram, 30 faths. (with ripe eggs; taken the 2. March), and some small specimens from the same locality. Some few small specimens were taken at Koh Chuen, 30 faths., Koh Mesan, 5—9 faths., 20 miles South of Koh Samit,

20 faths. and *S.* of Koh Kahdat, 8—10 faths. Further two medium-sized specimens were found in the Museum from the Gulf of Siam (SALMIN). The „Skeat“-Expedition took one large specimen off the East coast of Redang.

Even the smallest of the specimens (5 mm.) are perfectly recognizable by their pedicellariæ and the colour of the spines; in regard to the colour they are very similar to *dussumieri*, from which species they may, however, easily be distinguished by the globiferous pedicellariæ. (The alternation of the primary ambulacral tubercles in *S. dussumieri* is not seen in quite small specimens.) — In these small specimens there are, of course, only the two series of primary tubercles in each area; at a size of about 10 mm. a second, inner row of tubercles appears at the ambitus in the interambulacra; the pits are very distinct in the smallest specimens. The genital openings appear at a size of c. 9 mm. diameter.

Salmacis conica v. Martens is a synonym of this species. Dr. MEISSNER has kindly sent me the specimen (a naked test) from the Berlin-Museum, so that I can say with full certainty that it is identical with the typical form of *S. virgulata*.

The var. *Alexandri* (Bell) agrees completely, as regards pedicellariæ and spicules, with the typical form of *virgulata*.

10. *Salmacis sphæroides* (L.).

Pl. V. Fig. 23. Pl. VI. Figs. 1, 11, 41.

- Echinus spheroides* LINNÉ. 1758. Systema nature. Ed. X. p. 664.
 — — — 1764. Museum Ludovicæ Ulricæ. p. 706.
Salmacis sulcatus. L. AGASSIZ & DESOR. 1846. Catalogue raisonné d. Éch. p. 359 (55).
 — *festivus*. GRUBE. 1868. 45. Jahresber. Schles. Gesellsch. vaterl. Cultur. p. 43.
 — *sulcata*. AGASSIZ. 1872. Rev. of Ech. p. 476.
 — — — 1881. Challenger Ech. p. 114.
 — — STUDER. 1881. Echinoidea ges. von „Gazelle“. p. 873.
 — *sphæroides*. LOVÉN. 1887. Echinoidea descr. by Linnæus. p. 69. Pl. II.
 — *rurispina*. DE LORIOL. 1893. Échinod. de la Baie d'Amboine. p. 370.
 — — KOEHLER. 1895. Échinod. îles de la Sonde. p. 413.
 — *globator*. BEDFORD. 1900. Echinod. from Singapore and Malacca p. 282. Pl. XXII. 4. a. b.
 — *sphæroides*. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. (Semon) p. 716. Taf. LXIII. 1—4.
 — — DE MEJERE. 1904. Siboga-Echinoidea. p. 82. Taf. XVII. 272.

This species has been definitely settled by the researches of LOVÉN and DÖDERLEIN. That it is the same as *S. sulcata* Ag. can scarcely be doubted. In the Muséum d'histoire naturelle in Paris no type-specimen is preserved, but in the collection of l'École des mines there is a specimen from the Philippine Islands (without further indications) named *Salm. sulcata*; this is then probably a type-specimen. It is certainly *S. sphæroides*; with regard to pedicellariæ and spines it also completely agrees with that species.

In a specimen of 16 mm. diameter there are as yet only the two primary series of tubercles in both areas, the secondary tubercles all being quite small. The miliary tubercles at the distal side of the primary tubercles are elongated, thus looking as if they radiate from the primary tubercle. No genital openings have yet been formed; in a specimen of 18 mm. diameter they have appeared. Otherwise I have nothing to add to the description of the test given by DÖDERLEIN; only the pedicellariæ, spicules and the buccal membrane need to be mentioned.

The globiferous pedicellariæ (described and figured by DE MEJERE) are of one kind only, with 1—1 lateral teeth. The outer corners are produced, but not always so sharply as in the figured one (Pl. VI. Fig. 11). The tridentate pedicellariæ (Pl. VI. Fig. 1, 41) are rather small, ca. 1 mm. (head). The valves are very wide apart, joining only at the point; the blade is long, narrow, deep in the lower part, a little widened in the outer part. The edge is quite smooth or finely serrate below, coarsely sinuate at the point, where the valves join; this part of the edge is at an obtuse angle with the rest of it. There may be rather much meshwork in the blade. The ophicephalous and triphyllous pedicellariæ do not present obvious characters; the former are like those of *bicolor* or a little more elongate, the latter have the blade a little widened. — The spicules of the tube feet are mostly very scarce, except just below the sucking disk, where they may be found in great numbers.

The buccal membrane has, as usual, numerous small plates round the mouth, inside the buccal plates; outside these some spread plates may be found besides the usual thick plates, covered with pedicellariæ, placed opposite the gills. Numerous small bihamate spicules are found in the buccal membrane. The buccal plates may be covered with small tridentate or triphyllous pedicellariæ. — The walls of the intestine are provided with rather few small bihamate spicules; in the stone canal and ovoid gland they are more numerous and may be a little irregular. The genital organs are treeshaped; the stem and the main branches have the walls studded with very curious calcareous bodies, namely bihamate spicules, which have become closed to a ring and with a more or less complicate network on the outside of the ring. All transitional forms between the typical bihamate and the most complicated form are found (Pl. V. Fig. 23). In the finer branches of the genital organs only bihamate spicules are found, often in great numbers together on small spots, the rest of the branch being almost destitute of spicules; they are distinctly smaller than those in the stem. — Ripe eggs are found in specimens taken in February in the Gulf of Siam and in August in the Johore-Strait (Singapore).

A rich material of this species, small and large specimens, was taken at Koh Kram, 20—30 fathoms, Koh Mesan, 10—15 faths. and Koh Kahdat, 4—5 faths. Further a number of large specimens were taken by MARIUS JENSEN in Johore-Strait (Singapore) in August 1901. One of the latter specimens has the spines on the abactinal side almost quite white.

The var. *pyramidata* (Troschel) completely agrees with the typical form of *sphaeroides* in regard to pedicellariæ and spicules, and to the spicules of the genital organs. (I have examined the type-specimen in the Berlin-Museum.)

The var. *belli* Döderlein, on the other hand, is something quite different. The pedicellariæ agree exactly with those of *S. bicolor*, even in the tridentate pedicellariæ a reliable difference can scarcely be pointed out; there can be no doubt that it is very nearly related to that species, whereas it has nothing to do with *sphaeroides*. According to DÖDERLEIN (in a letter to me) it must be maintained as a distinct species; the most easily seen character of it is the green base of the spines; other characters of little importance may be found in the test (comp. DÖDERLEIN's description, p. 718). The buccal membrane contains very numerous bihamate spicules; the plates opposite the gills are covered with pedicellariæ, as are the buccal plates.

11. *Salmacis dussumieri* Ag.

Pl. VII. Fig. 15.

- Salmacis dussumieri*. AGASSIZ & DESOR. 1846. Catalogue rais. des Échinides. p. 359 (55).
Torenmalica concava. GRAY. 1855. An arrangement of the fam. of Echinidæ. Proc. Zool. Soc. p. 39.
Salmacis dussumieri. AGASSIZ. 1872. Rev. of Ech. p. 473. Pl. VIII. b. Figs. 7—8.
 — — BELL. 1880. On some Genera and Species of Temnopleuridæ, p. 429.
 — — RAMSAY. 1885. Catalog. Echin. Austral. Mus. I. p. 16, 49.
 — *lutea*. DÖDERLEIN. 1885. Seeigel von Japan u. d. Liu-Kiu-Inseln. p. 22.
 — *dussumieri*. LOVÉN. 1887. Echinoidea descr. by Linnæus p. 73.
 — — DUNCAN & SLADEN. 1888. Echinoidea of the Mergui Archipelago. p. 317.
Temnopleurus Reynaudi? BEDFORD. 1900. Echinod. from Singapore and Malacca. p. 281.
Salmacis dussumieri. DÖDERLEIN. 1902. Echinoidea von Amboina u. Thursday Isl. (Semon's Reisen). p. 715. Taf. LXIII. Fig. 5—5. c.
 — *sulcata*. BELL. 1903. Report on a Collection of Echinoderms from the Neighbourhood of Zanzibar. Part. I. Ann. Nat. Hist. 7. Ser. XII. p. 247.
 — *dussumieri*. DE MEJERE. 1904. Siboga-Echinoidea. p. 85.

This species differs so much from the other *Salmacis*-species, through the low form of the test, the deeply sunken peristome, and especially by having a primary tubercle only on every second ambulacral plate (which character has first been distinctly pointed out by LOVÉN, loc. cit., though BELL's expression: „when there are vertical rows of tubercles on each half of the ambulacral plates, the tubercles do not form transverse rows, but are set alternately“ (loc. cit.) may mean the same) that very little uncertainty has prevailed as regards it. To the descriptions in the works cited I may only add that the colour of the large spines at the ambitus varies rather much, from almost white with a few red rings at the outer end to intensely red in the whole length, with the rings at the outer end almost obscured. In such dark specimens also the small primary spines of the abactinal side are red, whereas in the light coloured specimens these spines are quite white. (A

very dark coloured form of this species I have seen in the British Museum, from Tuticorin (Thurston); the spines are greenish with brown rings. There does not seem to be any other difference from the typical form, so that it can only be regarded as a colour-variety. The *Salm. sulcata* named by BELL in his paper On Echinoderms from the Neighbourhood of Zanzibar (loc. cit.) is identical with this form of *S. dussumieri*.

The alternation of the primary ambulacral tubercles has already appeared in specimens of 6—7 mm. diameter; in younger specimens (and, of course, in the proximal part of the ambulacra of larger specimens) there is a primary tubercle on every ambulacral plate. The genital openings appear very early, being found already in specimens of ca. 5 mm., a curious difference from *S. sphaeroides*, where they do not appear till the animal has reached a much larger size, c. 17—18 mm. in diameter.

The pedicellariæ are so very like those of *S. sphaeroides* that scarcely a single characteristic feature can be pointed out; reference may simply be made to the figures given of the pedicellariæ of *sphaeroides*. The spicules of the tube feet are rather numerous and of the usual bihamate form. The buccal membrane, as in the other species, contains a number of small, irregular plates inside the buccal plates, forming a ring around the mouth; some few small, rounded plates may occur outside the buccal plates but not especially opposite to the gills. Bihamate spicules do not occur in great numbers in the buccal membrane; a few small, bow-shaped spicules may be found among them. The walls of the intestine are full of very small, bowshaped spicules. In the stone-canal the spicules are larger, elongate, more or less irregularly branched. The genital organs are bushshaped, with close, irregular branches. They are full of two kinds of spicules: the small, bow-shaped ones, which, however, mostly develop to larger, branched spicules (mainly in the stem), and very large, bihamate spicules (Pl. VII. Fig. 15).

A number of specimens of different sizes were taken at the following localities: Koh Kram, 30 fathoms, Koh Lan, 30 faths., between Koh Rin and Cliff Rock, 15 faths. (only small specimens), Koh Kam, 5 faths., Gulf of Rayong, 7—10 faths., 20 miles S. of Koh Samit, 20 faths., off Tung Kaben, 6 faths., S. of Koh Kahdat, 8—10 faths. Also from Singapore I have specimens, taken by Mr. GAD, 1903. — The species is found both on hard and on muddy bottom.

A number of species of *Salmacis* have been described besides those mentioned above, viz:

Salmacis varius Agass. (Catalogue raisonné des Échinides. p. 55.)

— *globator* Agass. (Ibidem.)

— *rubrotinctus* Grube. (45. Jahresber. Schles. Ges. vaterl. Cultur. 1868. p. 42.)

— *rufa* Bell. (Echinoderms from Macclesfield Bank. Proc. Zool. Soc. 1894. p. 411. Pl. XXVI. 2—3.)

- Salmacis* (?) *elegans* Bell. (Report on the Echinoderms collected by Dr. Willey. — A. Willey. Zoological Results. II. 1899. p. 135. Pl. XVII. 1.
- *Woodsii* Ramsay. (Catalogue of the Echinodermata in the Australian Museum. I. Echini. 1885. p. 18, 48. Pl. II. 1—3.

(„*S. Desmoulinsii* Agass.“ in DUJARDIN & HUPÉ: Histoire naturelle des Zoophytes Échinodermes. 1862. p. 516 is no doubt a printing error for *S. dussumieri*, which is not named there).

The type specimen of *S. varius* is no longer in the Paris-Museum, so we must be content with the assertion given by A. AGASSIZ (Rev. of Ech. p. 156) that it is synonymous with *rarispinga*.

The type-specimen of *S. globator* is to be found neither in the Museum of Paris nor in the collection of l'École des mines. What AGASSIZ describes under this name in „Rev. of Ech.“ is no doubt *S. virgulata*, var. *Alexandri*. The *S. globator* of BELL (On some genera and species of the Temnopleuridae p. 431) is partly (α) *S. virgulata*, var. *Alexandri*, partly (β) *S. sphaeroides*, var. *pyramidata*. A specimen from Dauma Island named *S. globator* is *S. belli*. The *S. globator* of „Challenger“ St. 146 is *S. Alexandri*. The *S. globator* of BEDFORD is *S. sphaeroides*. (All these specimens I have examined in the British Museum.) The *S. globatrix* of LÖVÉN probably is *bicolor* var. *rarispinga*.

S. rubrotinctus Grube is probably *S. bicolor*, but as the type-specimen cannot be found (DÖDERLEIN. p. 715), the question must remain a little uncertain.

S. Woodsii Ramsay cannot from the description be referred with certainty to any of the well known species. I have seen, however, in the British Museum a specimen from Holothurian-Bank (1892) which has exactly the same form as *S. Woodsii*, whereas it otherwise agrees completely with *S. belli* (only the large globiferous pedicellariae I have not found); but it is certainly a monstrosity. On the narrow part of the test some small irregular bodies occur, probably of parasitic nature. There can thus scarcely be any doubt that *S. Woodsii* is only a monstrosity of *S. belli* (or perhaps the same monstrosity may occur also in other species).

S. rufa Bell is a *Psammochinus*; some notes on this species are given below. *S. elegans* Bell is a young *Coelopleurus Maillardi* (Mich.). (The specimens were examined in the British Museum.)

Finally I may give some further notes of „*Salm. sulcata*“. What SLADEN names thus in his paper „On the Asteroidea and Echinoidea of the Korean seas“ p. 439, is probably *Satmacopsis olivacea*; the tubercles are noncrenulate. Unfortunately I could not find any globiferous pedicellariae on these specimens. — The *S. sulcata* of BELL from Port Denison (Echinoderms. „Alert“. p. 118) are partly *S. sphaeroides*, partly *S. dussumieri*. What is meant by *S. sulcata* in BELL's paper „On some genera and species of the Temnopleuridae“ I cannot say, as, unfortunately, I forgot to make any note of it during my visit to London last summer.

The genus *Melebosis* Girard is maintained by POMEL (Op. cit. p. 87) as separate from *Salmacis*. According to AGASSIZ (Rev. of Ech. p. 156) *Melebosis mirabilis* Gir. is synonymous with *S. sphaeroides (sulcata)*; but there is not the least reason to maintain this species as a distinct genus. Neither can the name *Diploporus* Troschel (for the var. *pyramidata* of *sphaeroides*) be made use of.

The *Salmacis*-species have for a long time had a very bad reputation as being most difficult to distinguish. Mainly through the researches of DÖDERLEIN combined with the investigations here recorded it has now been shown that only five easily distinguished species with some varieties are known; the difficulties are not due to the animals but to the insufficient or bad descriptions of previous authors. It may be desirable to give here an analytical table of the *Salmacis*-species¹⁾.

1. Globiferous pedicellariæ of two kinds, large ones without lateral teeth and small ones with an unpaired lateral tooth; tridentate pedicellariæ with short and broad valves. Spines ringed. The pores mostly not reaching the edge of the area; tubercles occur outside the pores 2.
 - Globiferous pedicellariæ of one kind, without or with 1—1 lateral teeth; tridentate pedicellariæ with narrow blade. Spines ringed or not 3.
 2. Spines with red base *S. bicolor* Ag. (with the var. *rarispinia*).
 - — green base *S. Belli* Döderl.
 3. Globiferous pedicellariæ without lateral teeth; spines not ringed. The pores reach to the edge of the ambulacral area; no tubercles outside the pores *S. virgulata* Ag. (with the var. *Alexandri*.)
 - Globiferous pedicellariæ with 1—1 lateral teeth. Pores on the buccal side and at the ambitus not reaching the edge of the area; with tubercles outside the pores 4.
 4. A primary tubercle is found on all the ambulacral plates; test rather high, peristome not much sunken *S. sphaeroides* Ag. (with the var. *pyramidata*.)
 - A primary tubercle is found only on every second ambulacral plate; test very low, peristome much sunken *S. dussamieri* Ag.

¹⁾ DÖDERLEIN and DE MEJERE have already given analytical tables of the species of *Salmacis*; as, however, I have made here several corrections of their views of these species, it seems not superfluous to give a new analytical table thereof.

The genera *Temnopleurus* and *Salmacis* are very nearly related, so nearly indeed that it seems impossible to find any character distinguishing between them with full certainty. To be sure DUNCAN¹⁾ has found in *Temnopleurus* only 4 parts in the „rosette“ of the sucking disk, in *Salmacis* 6—7 parts. This would give an easily accessible character distinguishing these two genera, but unfortunately it does not hold good. In all the *Temnopleurus*- and *Salmacis*-species I find the number of these plates to be 4—5, rarely 3 or 6. In *T. Reevesii* I have found only four, in *S. dussumieri* only five, but I do not doubt that in these species also the other numbers may occur. — The pedicellariæ and spicules do not afford generic characters here and so cannot be used for distinguishing the genera. Thus only the well known characters in the structure of the test are left for the distinction of the two genera, but none of these characters are exclusive. *Temnopleurus* has large grooves in the test, *Salmacis* only small pits: but *S. Alexandri* is almost like *Temnopleurus* and *T. Reevesii* almost like *Salmacis* in this respect. *Temnopleurus* has few series of tubercles, *Salmacis* has several series, both vertical and horizontal; but large specimens of *Temnopleurus* have also more (6) series of interambulaeal tubercles, arranged likewise in horizontal series, and young specimens of *Salmacis* have few series of tubercles as *Temnopleurus*. The form of the test is generally high in *Salmacis*, low in *Temnopleurus*, but *S. dussumieri* is as low as any *Temnopleurus*. Both ringed and uniformly coloured spines occur in both genera; also the buccal membrane is alike in both of them. There is thus not a single character which distinguishes sharply between the two genera. It will, however, be practical to maintain both the genera; it will scarcely ever be difficult to decide to which of them any species has to be referred. It is the two species *T. Reevesii* and *S. dussumieri* (together with the var. *S. Alexandri*) which cause the difficulties; if these two species were removed from the genera there would be excellent characters distinguishing *Temnopleurus* and *Salmacis*; only the var. *Alexandri*, which cannot be excluded from the genus *Salmacis* on account of its evident near relation to *S. virgulata*, will remain as a form intermediate in characters between the two genera. The two above named species would then have to be made the types each of a separate genus, as it would be impossible to unite them into one genus. This might not be unreasonable. The name *Toreumatica* Gray should then be used for *Reevesii*, whereas the name *Diploporus* Troschel might be used for *dussumieri*. I do not feel sure, however, which is the better arrangement, and for the present I leave these species in the genera, where they have been placed for so long a time, and with which they are evidently most nearly related.

¹⁾ On the Anatomy of the Temnopleuridae. Ann. Nat. Hist. 6. Ser. I. 1888. p. 127.

12. *Pleurechinus Döderleini* n. sp.

Pl. I. Figs. 12, 13. Pl. II. Figs. 1, 7, 8. Pl. VI. Figs. 35, 43. Pl. VII. Figs. 10, 48.

The form of the test is rather variable. The largest specimens (12 mm. in diameter) are rather high (10 mm.) and conical, the smaller ones are generally more flat (7 mm. high to 10 mm. in diameter for instance). The lower side is rather flat and a little incurved at the peristome.

The ambulacra (Pl. II. Fig. 8) are only a little narrower than the interambulacra. The pores are rather large, disposed in an almost straight series, the middle pair in each compound plate being placed scarcely so much as half the width of a single pore outside the two other pairs; they are not placed close to the edge of the area, in the largest specimens there are even some small tubercles outside the pores. The interporiferous zone is twice as broad as the poriferous. The primary tubercles—one to each compound plate—form a distinct series close to the poriferous zone; above each primary tubercle there is a smaller secondary one, placed in the same line as the primary ones. On the inner part of the plate there may be (in the larger specimens) a pair of secondary tubercles, or this part of the plate may be covered by miliary tubercles. The ambulacral plates are as high as the interambulacral ones, the number of plates being almost exactly the same in both areas (12–13 in specimens of 10–12 mm.). The pits are large and deep, rectangular, reaching to the base of the primary tubercles; they are indistinct on the 2–3 lowermost plates. The pits along the outer edge of the ambulacral plates are distinct, those in the sutures between the compound plates being distinctly larger than those at the sutures of the primary components of the ambulacral plates; they sometimes unite with the outer interambulacral pits, which are of the same size as the ambulacral ones.

In the interambulacral areas (Pl. II. Fig. 7) the primary tubercles likewise form a very distinct series. The secondary tubercles are not arranged in a horizontal row on each plate; there may be 2–3 larger ones outside and inside the primary tubercle and one above the primary tubercle at the upper side of the plate. The secondary tubercles of each plate thus form an oblique series on each side of the primary tubercle, meeting at a right angle in the tubercle placed above the primary one. The miliary tubercles may be rather scarce or they may occur in great numbers, covering the whole plate; in the latter case the secondary tubercles are very inconspicuous, and hardly larger than the miliary ones. The pits are very large and deep, leaving only a narrow band free in the middle of the horizontal suture, as broad only as the base of the primary tubercle. Both the inner and outer pits are a little widened towards this part. A distinct covering membrane may be seen along the edge of the pits (comp. *Pl. siamensis*).

The apical area (Pl. II. Fig. 1) is small, 2.5 mm. in diameter in a specimen of 10 mm. diameter of test. At the inner end of the ocular plates there is a distinct

depression; no ocular plate reaches the periproct. Along the inner edge of the genital plates there is a close ring of tubercles; one tubercle on each ocular plate. The periproct is covered by very small, rounded plates, all of the same size; the anal opening is central.

The buccal membrane shows the quite unique feature that there are only five buccal plates and tentacles; the plates are small, round, green. In the inner border of the buccal membrane, close around the mouth, there is a narrow ring of small, rather thick, greenish plates; all the rest of the buccal membrane is naked, with a few bihamate spicules. The gills are small, with the usual, irregular fenestrated plates. The mouthslits are very small and indistinct. The auriculæ are connected and very variable in shape. The diameter of the peristome is rather large: 4.5 mm. in a specimen of 12 mm. diameter, 4.2 mm. in a specimen of 10 mm. diameter — c. 37 — 42% of the diameter of test.

Pedicellariæ. The globiferous pedicellariæ (Pl. VI. Fig. 35. Pl. VII. Fig. 10) have an unpaired lateral tooth almost as large as the endtooth; the blade may be

quite open or with a more or less broad crossbeam over the inner side. The outer corners are rather sharp but not produced. The glands are double — as usual among the Temnopleurids. The ophicephalous pedicellariæ have a short neck; the blade is rather short, without meshwork, only with a median keel; the edge is a little sinuous and distinctly serrate (Pl. VII. Fig. 48). Tridentate pedicellariæ I have not found. The triphyllous pedicellariæ (Pl. VI. Fig. 43) are very small, a little elongate, with smooth outer edge. The sphæridiæ are placed at the pits of the 5—6 inferior plates. The spicules are extremely scarce; in the tube feet and the internal organs I have found none, only in the buccal membrane a few bihamate ones have been found.

The spines (Fig. 6) are short and slender, c. $\frac{1}{3}$ of the diameter of the test (in larger specimens); they are a little thorny in the outer part, the point not swollen, ending in a central thorn with a circle of points around, all small and rather indistinct. The actinal spines are not curved or widened at the end.

The colour of the test is green with some irregular white spots, and sometimes a reddish tint in the median part of the interambulacral areas. The edge

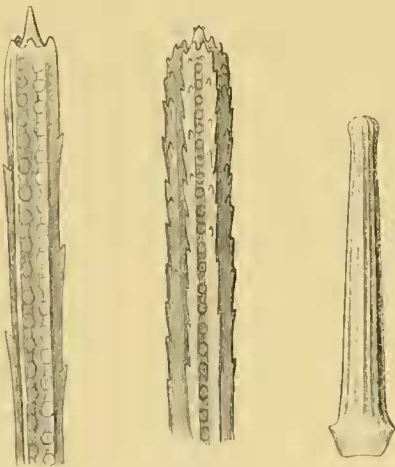


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 5. The point of a secondary spine of *Pleurechinus scillæ* (Seibert. Obj. II. Oc. III.).

Fig. 6. The point of a primary spine of *Pleurechinus Döderleini*. (Seibert. Obj. 0. Oc. 0.)

Fig. 7. A primary spine of *Pleurechinus siamensis*. (Seibert. Obj. II. Oc. III.)

of the ambulacra, outside the pores, is reddish. The spines are green, often reddish brown in the middle, whitish in the outer part; they are not ringed.

Off Tung Kaben, 6 fathoms; sandy mud (6 specimens). Koh Mesan, 5—9 fathoms (10 specimens). A specimen was taken at Singapore by Mr. GAD. Prof. DÖDERLEIN kindly tells me he has a specimen of this species from Samoa.

This beautiful and very interesting species is very distinct from all the other species of *Pleurechinus* (comp. those described below). It is above all distinguished by the very remarkable feature of having unpaired buccal plates and buccal tube feet. (Also in young specimens of *Hypsiechinus* and *Prionechinus* may be found only 5 buccal tube feet, but there are always 10 buccal plates. I have also seen a specimen of *Pl. bothryoides* in which one of the buccal plates, in one pair only, was rudimentary and without tubefoot, the other plate bearing two feet; the other pairs were normally developed. Likewise in a specimen of *Pl. variegatus* I have found the one tubefeet wanting in one of the pairs of buccal plates.) Possibly it ought to be made the type of a separate genus; but as it is otherwise a typical *Pleurechinus*, I think it best to retain it in this genus. If in the future more species with this disposition of the buccal plates and tube feet should be made known, there might be more reason to make a separate genus for their reception.

13. *Pleurechinus siamensis* n. sp.

Pl. I. Figs. 2, 7, 11, 20. Pl. II. Figs. 2, 9, 14, 15, 22. Pl. VI. Figs. 16, 36. Pl. VII. Figs. 14, 44, 53.

The test is low, 5 mm. high in a specimen of 7.5 mm. in diameter. The actinal side is flat, not distinctly incurved at the peristome: mouthslits quite indistinct. Peristome 3.2 mm. to a diameter of test of 7.5 mm., c. 40% of the diameter of test.

The ambulacra (Pl. II. Fig. 2) are $\frac{2}{3}$ as broad as the interambulacra. The pores are very small, disposed in a single straight series and close to the edge of the area. The poriferous zone is very narrow, without any tubercles, scarcely $\frac{1}{3}$ so broad as the interporiferous zone. The ambulacral plates are as high as the interambulacral ones, their number being the same, 9—10 in a specimen of 7.5 mm. diameter. The primary tubercles, one to each compound plate, form a distinct series close to the poriferous zone; they are of the same size as the interambulacral primary tubercles. The base of the primary tubercles of both areas is a little stellate reminding one of *Genocidaris maculata*. (Also in *Pl. Döderteini* there may be a very faint indication of a stellate condition.) Secondary tubercles rather few and small, only at the ambitus they may be distinct, forming a small inner series on a few (3—4) plates. The pits are large, deep, rectangular, with the ends a little rounded. Also on the lower side they are distinct, except on the first 1—2 plates. The pores along the edge of the ambulacra very indistinct.

In the interambulacral areas (Pl. II. Fig. 9) the primary tubercles are, as in the ambulacra, a little stellate, disposed in a distinct longitudinal series. The

secondary tubercles are rather numerous, small, not disposed in distinct series. Miliary tubercles not very numerous. The median part of the interambulaera is naked on the upper 3—4 plates. The pits are large, rectangular, deep, leaving only a narrow band free in the middle of the horizontal suture, as broad only as the base of the primary tubercle; they are distinct also on the lower side.

Along the edge of the pits in both areas there is a rather broad membranous brim, leaving only a small oval hole in the middle (Fig. 8).



Fig. 8. Part of interambular area of *Pleurechinus siamensis*; showing the membrane covering the pits. (Seib. Obj. 9. Oc. 9.)

DUNCAN (On the genus *Pleurechinus*, its classificatory position and alliances. Journ. Linn. Soc. Zoology. XVI. 1882. p. 453) has evidently seen the same structure in *Pleurech. bolhryoides*. It seems probable that these large pits may have some special function. I have made sections of the test in order to see if there be any special histological structures indicating sensory organs or the like, but failed to see anything of that kind. The preservation of my specimens, however, is not good enough for settling the question. There is nothing to support the suggestion that they may have something to do with the hatching of the eggs and young ones (DUNCAN. p. 453). It might seem reasonable to ascribe to

these structures a respiratory function; but observations on the living specimens and histological researches on specimens preserved for that purpose are needed for settling the question.

The apical area (Pl. II. Figs. 14—15) is rather large, 2.8 mm. to a diameter of test of 7.5 mm. The depression at the inner end of the rather large ocular plates may be large and almost tripartite or quite indistinct. There is a distinct secondary tubercle on each ocular plate; none of the plates reaches the periproct. The form of the ocular plates is peculiar, the part outside the pore looking like a small, separate, white plate. The ocular pore cannot be seen from above, as is generally the case in the *Pleurechinus*-species. The genital plates have 1—3 tubercles at the inner edge; the outer part is mostly dark coloured. Genital openings rather large. The periproct is covered by one large anal plate and a few smaller plates; the anal opening is excentric.

The buccal membrane is naked, with rather numerous, very slender, but rather large bihamate spicules (Pl. VI. Fig. 16). Along the inner edge around the mouth there is a single series of small irregular plates. The buccal plates are small, round, colourless (not green as in *Döderleini*); they are paired, and all 10 buccal tube feet are developed as is normally the case in Echinids. The gills contain the usual irregular plates. The auriculæ are rather large and connected.

The globiferous pedicellariæ (Pl. VI. Fig. 36. Pl. VII. Fig. 14) have no distinct lateral teeth, only a rounded knob on the one side; the blade is of medium length, the basal part evenly rounded. The ophicephalous pedicellariæ (Pl. VII. Fig. 44)

have a rather well developed meshwork in the outer part of the blade. Tridentate pedicellariæ have not been observed. The triphyllous pedicellariæ (Pl. VII. Fig. 53) are small and simple. — Sphæridiæ are found on the 4–5 lower plates. Spicules have been met with only in the buccal membrane, and a few of the same shape as those in the buccal membrane, in the walls of the genital organs.

The spines (Fig. 7) are short, the longest about $\frac{1}{3}$ — $\frac{1}{4}$ of the diameter of the test; they are rather robust, smooth, a little swollen at the point. Those around the peristome are flattened at the end and curved. The smaller ones end in a distinct central point with a circle of smaller points around; in the larger ones the point is rounded (Pl. II. Fig. 22). They are white with one or two narrow greenish bands. Sometimes the base is reddish, and then the primary tubercles likewise are reddish.

The colour of the test is greenish with some irregular white spots. The median naked part of the interambulacra on the abactinal side is mostly darker coloured; there is thus formed a star-shaped figure on the abactinal side. A small specimen of 3.5 mm. diameter has the interambulacra beautifully red, and in a larger naked test (10 mm.) the interambulacra are a little red at the ambitus. These specimens otherwise agree completely with the rest.

Koh Mesan, 3—15 fathoms (9 specimens); Koh Chuen, 15—38 faths. (7 specimens); Koh Kram, 20—30 faths. (2 specimens); Koh Kahdat, 10 faths. (1 specimen).

This small species proves to be very widely distributed in the Indo-Pacific Ocean. In the collections of the British Museum I have found some specimens from the Seychelles, 12 fathoms (named *Salmacis bicolor*? young), from Holothurian Bank, North Australia, 15 fathoms (named *Temnopleurus* young) and from the Amirante Islands, 17 fathoms (named *Salmacis bicolor*, young?), which I must refer to *Pl. siamensis*, in spite of some minor differences. A specimen from Torres Strait (HADDON) found among some Echinids sent me for examination by Prof. S. F. HARMER in Cambridge, must likewise be referred to this species. It is 12 mm. in diameter, 8 mm. high, and is the largest specimen of this species that I have seen. (Pl. I. Figs. 7, 11. Pl. II. Figs. 2, 9, 14.) Also the „Siboga“-Expedition has dredged several specimens of this species. — Seeing from DE MEJERE's remarks on *Pleurech. bothryoides* („Siboga“-Ech. p. 77) that probably more than one species had been included under this name, I asked Dr. DE MEJERE to let me see the specimens, and he most kindly sent me all of them. As supposed, I found them to belong to several species, viz. *Pl. maculatus* (described below), *siamensis* and *scillæ*, besides the true *bothryoides*. The species *siamensis* was found to occur in many of the stations (enumerated on p. 202 of the „Siboga“-Echinoidea), being thus very common in the Malay Archipelago.

All these specimens show the species to be very variable. Several of the specimens from „Siboga“ are quite like those from the Gulf of Siam; others are much darker, brownish with white spots or quite brown. The specimens from the

Seychelles and from Holothurian Bank are almost white; the spines are less thickened at the point than in the typical form; the pits between the ocular and the genital plates are very distinct, and the genital plates bear several tubercles along their inner edge, forming a circle round the periproct. Perhaps the secondary tubercles are also a little more numerous than in the typical form. In the specimen from Torres Strait the secondary tubercles are distinctly more numerous. These are, however, very trifling and unreliable differences, so that I find it necessary to regard them all as belonging to one species. Only one form I must regard as a distinct variety. It is beautifully red coloured, both on the test and spines, and thus looks very different from the typical *siamensis*. I am, however, unable to find other characters than the colour by which it can be distinguished from that species, and the colour sometimes is little intense. The anal opening may be subcentral. This variety, which I may name var. *pulehellus*, n. var., I have seen from the Amirante-Islands and from the Maldive-Islands; further it was found in the „Siboga“-collection, from the Stations: 43, 104 and 240.

The genus *Pleurechinus* proves to be represented by a considerable number of species in the Indo-pacific Ocean. Untill recently only the one species *Pl. bothryoides* was known, and it was considered a great rarity. In 1885 DÖDERLEIN (in his paper „Seeigel von Japan und den Liu-Kiu-Inseln“) described two new species, *Pl. ruber* and *variabilis*. BELL (Echinoderms of Macclesfield Bank. 1894. p. 410) points out that *Pl. bothryoides* now has been shown to be „by no means a rare species“ — but as to the species described by DÖDERLEIN he has „a pretty strong conviction that the progress of research will result in showing that *Pleurechinus variabilis* and *P. ruber* of Dr. DÖDERLEIN are synonyms of this variable species“. In his recent work on the Echinoidea from Amboina and Thursday Island (Semons Reisen) (p. 705) DÖDERLEIN maintains his species against BELL, and with full right. I have examined the type specimens of all the three species hitherto described, as well as the specimens from Macclesfield Bank determined by BELL as *Pl. bothryoides*, and I find *Pl. ruber* to be a very distinct species, whereas *Pl. variabilis* is so far from being synonymous with *Pl. bothryoides* that it cannot even be retained in the same genus; it belongs to the genus *Opechinus* Desor, hitherto known only as fossil. The specimens from Macclesfield Bank are not *Pl. bothryoides* either but a distinct species, described below as *Pl. maculatus* n. sp. In the collections of the British Museum I have further found a number of small specimens of *Pleurechinus*, identified as young *Temnopleurus* or even as *Temnopleurus toreumaticus*. As I could not examine all these specimens sufficiently during my visit at the British Museum, Prof. BELL kindly sent me the whole material to Copenhagen. By the close examination of these specimens they were found to belong to three different species of *Pleurechinus*, viz. the above named *Pl. maculatus*, *siamensis*, and one species more which has proved to be identical with the „*Temnoplechinus*“ *scillæ*, described by MAZZETTI. Further the Copenhagen-Museum possesses

a number of specimens of a *Pleurechinus* from East Asia, which likewise prove to be a new species; it is described below as *Pl. variegatus* n. sp. — The description of these new species may be preceded by a few notes on the two previously known species, *Pl. bothryoides* and *ruber*.

Pleurechinus bothryoides Agass. differs from all the other *Pleurechinus*-species in having a distinct, though small, lateral tooth on either side below the endtooth in its globiferous pedicellariæ (Pl. VI. Fig. 5—6). The basal part is narrow, without produced outer corners, but otherwise rather variable in form, as shown by DE MEJERE, who first described and figured these pedicellariæ („Siboga“-Echinoidea. p. 77. Pl. XVI. Fig. 267—68). In this species also tridentate pedicellariæ occur. They are small (ca. 0.2 mm. head), with the valves joining only at the point. The blade is narrow, simple, widened at the point; the edge is straight, except in the widened outer part, where it is coarsely sinuate and extremely finely serrate (Pl. VI. Fig. 38. Pl. VII. Fig. 9). The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 5, 51) do not present any peculiar features. The buccal membrane contains rather numerous bihamate spicules, and there is a border of small irregular plates round the mouth. In the tube feet I have found no spicules. The spines are smooth, not swollen at the point, ending in a more or less distinct central thorn. They have two or three beautiful red bands in the outer part. There is a transverse line on the genital plates.

In the description of this species (Rev. of Ech. p. 465) AGASSIZ says: „There are four deep disconnected pits of about equal size along the sutures of the plates above the ambitus“. Later on, in the „Challenger“-Echinoidea (p. 108) it is said: „in the interambulacral area there are two disconnected elliptical pits at the two extremities of the horizontal sutures“, and the same is shown by the beautiful figure (Pl. X.a. fig. 2). These two statements are evidently contradictory and might seem to indicate that the examples described in the „Challenger“-Echinoidea (and by DÖDERLEIN) were not the same species as the type of *Pl. bothryoides* described in „Rev. of Ech.“. As it was rather important to get this question settled, I asked Prof. DOUVILLÉ if he would lend me the type specimen (from the collection of L'école des mines in Paris) for examination. Prof. DOUVILLÉ most kindly sent me the precious specimen, for which service I beg him here to take my best thanks. The type specimen (labelled „Coll. Michelin, Iles Gallopagos“) proved to be an uncommonly large (40 mm. in diameter, 31 mm. high), beautiful, naked test of the species figured in the Chall. Ech. and by DÖDERLEIN, having thus only two large, deep, disconnected pits along each horizontal interambulacral suture and one in each ambulacral horizontal suture. The „four deep disconnected pits“ AGASSIZ must either have found by reckoning the whole width of the Interambulacra, or perhaps he really saw such a form (such recent forms really existing — comp. „*Pleurech. variabilis*“ and the new species of *Opechinus* described below) and then confounded his notes of the two forms. The note that the type specimen of *bothryoides* is „in

such a condition that no description of any value can be made" also seems to indicate a confounding of notes on different forms; the type specimen of *bothryoides* is in excellent condition, and as AGASSIZ does not otherwise give much more than descriptions of the tests, it seems difficult to understand, why this most characteristic form could not be described from the test alone. — The colour of the test in the type specimen is (now) grey, with a faint violet tint; it is not dark violet as stated by AGASSIZ; perhaps it was so, when he examined it.

The specimens recorded in the literature under the name of *Pleurechinus bothryoides* are not all really that species. The specimens from Kobi, Japan (Chall. Ech. p. 109) probably belong to the species *Pl. variegatus*, described below; in any case they are not *bothryoides*. The specimens from Chall. St. 186 are actually *bothryoides*. Of the specimens mentioned under this name by DE MEJERE (Siboga-Ech. p. 77) only three large specimens from Jedan (St. 273) are really *bothryoides*; the rest are *Pl. maculatus*, *siamensis* and *scillæ* (see above p. 81; „Siboga“-Ech. p. 202). The specimens from Thursday Island, Torres Strait, mentioned by BELL (Echinodermata — „Alert“ p. 119) are really *bothryoides*; whereas the specimens from Macclesfield Bank mentioned by BELL as *Temnopleurus bothryoides* (Echinoderms of Macclesf. Bank. p. 410) are *Pl. maculatus*. (The „Challenger“-specimens, as well as those from Thursday Island and Macclesfield Bank I have examined in the British Museum.) The *Temnopleurus cavernosus* of Woods is probably this species.

Pleurechinus ruber Döderlein. To the description of the test given by DÖDERLEIN¹⁾ may only be added that the anal opening is central and that no distinct anal plate is found. The spines are smooth, not swollen at the point; the actinal spines are not widened at the point and not curved. The globiferous pedicellariæ have no lateral teeth, only a rounded knob on one side below the endtooth; the blade is very short, the basal part with sharp, but not produced, outer corners (Pl. VI. Fig. 28, Pl. VII. Fig. 6). The ophicephalous pedicellariæ are like those of *bothryoides*; triphyllous (and tridentate) pedicellariæ I have not seen; the triphyllous ones will probably be like those of *bothryoides*, as is the case in *Pl. variegatus*, with which species it otherwise completely agrees as to pedicellariæ; tridentate pedicellariæ probably do not occur at all.

Pleurechinus variegatus n. sp. (Pl. I. Figs. 5—6, 8, 19). The test is low (7 mm. to 11.5 mm. in diameter, 11 mm. high to 17 mm. in diameter), beautifully rounded above, a little curved inwardly at the peristome. The pits (in both areas) are small, not reaching to the base of the primary tubercles, leaving thus a rather large part of the horizontal suture not deepened; no covering membrane is seen round the edge of the pits. The primary tubercles (of both areas) form distinct longitudinal series, diminishing very little in size towards the apex and the peristome; they are almost equally large in both areas. In larger specimens the tubercles are rather

¹⁾ Seeigel von Japan und den Liu-Kiu-Inseln. p. 20.

distinctly crenulate, and there may be indications of a stellate structure at their base. The secondary tubercles are rather numerous, in larger specimens very crowded, forming more or less distinct vertical and horizontal series; especially inside the primary series there is a vertical series of secondary tubercles, which may be almost as large as the primary ones; they may be more distinct in the ambulacra than in the interambulacra. The pores are very small, disposed in a very nearly straight series, close to the edge of the area (only at the ambitus a little distant from the edge in the largest specimen), no tubercles being found outside the pores. The poriferous zone is very narrow, only ca. $\frac{1}{7}$ — $\frac{1}{8}$ as broad as the interporiferous zone. The ambulacral plates are as high as the interambulacral ones, their number being the same. The small pits at the outer edge of the area are very indistinct or quite wanting.

Apical system (Pl. II. Fig. 6). The genital plates show the peculiar feature of the outer part with the genital opening being separated from the inner part by a distinct, mostly curved line, so that it seems as if the plate were divided in two parts, which is, however, not really the case. Sometimes the transverse line is obscured by tubercles, but never, so far as my experience goes, on all the plates; on the madreporite it is never distinct. The outer part of the genital plates is mostly darker coloured than the inner part. There is a circle of tubercles along the inner edge. The genital opening is placed near the outer edge. The ocular pore is placed on the outer edge of the rather thick ocular plate and cannot be seen from above; the part of the plate outside the pore is white and looks like a small distinct plate. The depression between ocular and genital plates is small and indistinct. The anal opening is not central; there is a distinct anal plate.

The buccal membrane contains rather many bihamate spicules; the plates along the oral edge may be rather numerous (a fact which depends on the size of the animal, in all probability). The buccal tubefeet may sometimes be placed one outside the other; in one specimen I have found the one tubefoot wanting in one of the pairs, a fact which is not without interest, considering the curious instance of *Pl. Döderleini* having all the buccal tubefeet constantly unpaired. — The spines are short ($\frac{1}{3}$ — $\frac{1}{4}$ of the diameter of test), smooth, not thickened at the point; the actinal spines are not widened or curved. — The globiferous pedicellariæ are quite similar to those of *Pl. ruber*, and reference may simply be made to the figures given thereof for that species. The triphyllous pedicellariæ are quite similar to those of *bothryoides*. The ophicephalous pedicellariæ do not present peculiar features. Bihamate spicules may be rather numerous in the walls of the intestine. — The colour of the test is gray or grayish-yellow, with some white spots; the pore areas are white. The spines are faintly greenish or whitish with a faint red tint at the base and a darker band in the outer part.

Specimens of this species have come from the following localities: Formosa-Channel, 35 fathoms (Suenson); Lat. $32^{\circ} 22' N.$, long. $128^{\circ} 42' E.$, 170 faths. (Suenson);

Lat. 33° N., long. 129° 24' E., 30 faths. (Schönau); Lat. 23° 57' N., long. 118° 33' E., 28 faths. (Schönau); Lat. 35° 5' N., long. 128° 22' E., 25 faths. (Schönau); Lat. 25° 28' N., long. 120° 29' E., 36 faths. (Schönau). Further Prof. DÖDERLEIN has taken the species in Sagami-Bay, at Yogashima and Katsiyama, Japan (he has kindly lent me the specimens for examination); it is this species which is figured in Pl. LXI. Fig. 5, 5a of DÖDERLEIN'S „Echinoidea von Thursday Island und Amboina“ under the name of *Pleurech. variabilis* juv.

Perhaps there will prove to be one more species of *Pleurechinus*, allied to *ruber* and *variegatus*, in the Japanese seas. Among the specimens sent me from Prof. DÖDERLEIN there is a specimen with larger pits and fewer tubercles than *variegatus*; the anal opening is central. Otherwise it agrees with *variegatus*. Whether or not it be really a distinct species, I shall not try to decide from the scanty material before me.

The two species, *ruber* and *variegatus*, are evidently nearly related, both agreeing in having much smaller pits than the other species of *Pleurechinus*. They are easily distinguished from each other. The pores are much larger in *ruber* than in *variegatus*; the tuberculation is also rather different. Finally the different colour instantly conveys the impression of their being two very distinct species. — *Pl. variegatus* has also some resemblance to *siamensis* as to habitus; it is, however, very easily distinguished from that species by the small pits, the numerous tubercles, the not thickened spines, the impression on the genital plates, besides by the form of the globiferous and triphyllous pedicellariæ.

Pleurechinus scillæ (Mazzetti) (Pl. I. Figs. 9—10, 17—18). — The description and figures of „*Temnechinus*“ *scillæ* given by MAZZETTI¹⁾ are very insufficient, being made from a naked test, in which even the apical system was wanting. It is only possible to see with certainty that it is no *Temnechinus* but a *Pleurechinus*, as pointed out by DE MEJERE (though not *Pleurech. bothryoides* as he supposes). (Siboga-Ech. p. 79.) Finding that some of the specimens of *Pleurechinus* before me were probably identical with this species, I asked Prof. ROSA in Modena to lend me the type-specimen for comparison; he very kindly sent it to me, for which service I beg him to take my best thanks. The comparison did not leave any doubt that my specimens were really identical with the „*Temnech.*“ *scillæ*, and I am thus able to give a more detailed description of this hitherto very insufficiently known species and to assign to it its true place in the system.

The specimens from the British Museum which led me to suppose the identity with *Pl. scillæ* were taken at Muscat, in the Persian Gulf, thus very near to the place from which the type-specimen had come. Together with these specimens there was a pair of specimens from New Britain (Collection WILLEY²⁾), differing

¹⁾ Gli Echinidi del Mar Rosso. Mem. della R. Acad. di Sci. di Modena. 2 Ser. X. 1894. p. 213.

²⁾ Mentioned by BELL in his paper on the Echinoderms collected by Dr. WILLEY as *Temnopleurus* young. WILLEY. Zoological Results. II. 1899. p. 135.

so much (especially by their large anal plate) from those from Muscat that I could not doubt that they belonged to a distinct species. The rich material of *Pleurechinus* from the „Siboga“-Expedition, however, yielded so many forms intermediate between the specimens from New Britain and Muscat that I must regard these as the two extreme forms of one very variable and widely distributed species. In the „Siboga“-Ech. p. 202 this species is mentioned under the name of *Pleurech. reticulatus*, as I could not at that time say with certainty whether it was identical with *Pl. scillæ* or not, having not yet seen the type specimen.

The test is low (6 mm. high to a diameter of 9 mm.), beautifully rounded above, almost flat below. The pits (in both areas) are large, reaching to the base of the primary tubercles, leaving only a small part of the horizontal suture not deepened (Pl. II. Figs. 4, 13); they are generally narrowed in the middle, rounded at both ends, the end looking towards the primary tubercle being the wider; the ambulacral pits are more regular in outline. There is a distinct covering membrane round the edge of the pits. The surface of the plates looks very different in the extreme forms of the species; but intermediate conditions are found. In those from New Britain the primary tubercles (in both areas) are little conspicuous, some few of those at the ambitus being a little larger than the others; their base is very distinctly stellate, undermined, as it were, by a circle of deep, round pits. Along the middle of the plate there is a depression in continuation with the pit in the opposite suture. The plates thus get a very reticulated surface (Pl. II. Fig. 13). The secondary tubercles, which are of about the same size as the primary ones, are arranged in a more or less distinct zigzag manner, forming oblique transverse series between the primary tubercles of the two series. Outside the primary interambulacral tubercles there are a few secondary tubercles. No vertical series are formed by the secondary tubercles. — In the specimens from Muscat the primary tubercles are more distinct, with only faint traces of a stellate condition of their base. There is no distinct median depression on the plates, and the secondary tubercles are not arranged in oblique series. — The pores are small, disposed in a straight line, close to the edge. The poriferous zone is very narrow, only c. $\frac{1}{4}$ as broad as the interporiferous zone. The plates of both areas are equally high, their number being the same (9 in a specimen of 8 mm. diameter). No pits are seen along the edge of the ambulacral areas.

The apical system (Pl. II. Figs. 10, 12) in the specimens from New Britain shows the peculiar feature of the periproct being completely covered by one large anal plate, no small plates being found besides it. In other specimens some few small plates are found on one side, and in the specimens from Muscat several small plates are found, the anal plate being, however, very large. The pits at the inner angle of the ocular plates is large, generally divided in two or three almost or quite separate pits. The ocular pore is directed outwardly, generally not seen from above. The genital plates have some more or less distinct depressions, the outline

being rather sinuate; there is sometimes a distinct transverse line over the outer part of the genital plates. The genital opening is placed almost in the middle of the plate. One or two small tubercles are found at the inner edge of the genital plates and one in the middle of the ocular plate.

The buccal plates may be placed one outside the other in each pair or equally distant from the edge. The plates along the inner edge of the buccal membrane are very faintly developed or even totally wanting, and the same holds good for the bihamate spicules. — The spines are short, the longest being about half as long as the diameter of the test; they are slender, not widened at the point, except those at the peristome, which are flattened and a little widened, and also a little curved. The primary spines are more or less thorny, sometimes, however, quite smooth, though — so far as my experience goes — never all of them in the same specimen; the secondary spines (Fig. 5) are generally more thorny, ending in a large central thorn, surrounded by small ones at its base.

The globiferous pedicellariæ (Pl. VI. Fig. 13, Pl. VII. Fig. 25) have no lateral teeth, only a rounded knob on each side below the endtooth. The outer corners of the basal part are sharp and generally a little produced. The ophicephalous and triphyllous pedicellariæ do not differ from those of *siamensis*. — Spicules I have not seen in the tubefeet, but at the base of the spines some few may be found.

The colour is rather variable: whitish with faint brownish spots, which are often most prominent between the primary tubercles in each series, or brown with a white spot in each area near the ambitus; the interambulacra may be darker coloured, forming thus a starshaped figure on the upper side of the test, as may also be the case in *siamensis*. The genital plates are mostly white in the middle, the edge being brown; in lighter coloured specimens there is only a brown spot at the two inner corners and one at the outer end of the plate. The primary spines are whitish with one or two faintly reddish bands.

This very small species (the largest specimen, I have seen, is 9 mm. in diameter) is evidently very widely distributed in the Indo-Pacific Ocean, being known from the Red Sea, the Persian Gulf, the Malay Archipelago and New Britain. For the localities where it has been dredged by the „Siboga“ reference must be made to DE MEJERE'S work (p. 202). — It is evidently most nearly related to *siamensis*, from which species it is, however, easily distinguished, mainly by its thorny spines which are not thickened at the point. Specimens like those from Muscat otherwise may look very like *siamensis*. The large anal plate is a very interesting feature, and the reticulate condition of the plates and tubercles reminds one of *Genocidaris*, showing thus that the reticulate or grooved condition of the plates is no exclusive character of such genera as *Trigonocidaris* and *Genocidaris*. (Comp. below: the classification of the Temnopleurids.)

Pleurechinus maculatus n. sp. (Pl. I. Figs. 4, 14). This species very closely resembles *Pl. bothryoides* in the form and structure of the test. The pits are somewhat variable in size, sometimes not reaching to the base of the primary tubercle; those at the outer edge of the ambulacral areas are generally less distinct than in *bothryoides*. There is a well developed covering membrane along the edge of the pits, which will probably be found to be the case also in *bothryoides*. (Comp. DUNCAN. On the genus *Pleurechinus*.) The pits at the inner edge of the ocular plates likewise are somewhat variable in size. The genital plates (Pl. II. Fig. 5) have the outer part, with the genital opening, depressed and marked off from the inner part by a sinuate transverse line, as is the case also in *bothryoides* and *variegatus*. It is especially distinct in smaller specimens. The anal opening is central or subcentral; the plates of the periproct are rather large, and the anal plate is distinct. The spines are smooth, generally distinctly knobshaped at the tip; the actinal ones are widened and curved. — The globiferous pedicellariæ (Pl. VI. Fig. 20, Pl. VII. Fig. 17) have no lateral teeth, only a small rounded knob on either side; only in one instance have I found the lateral teeth distinctly developed); the outer corners of the basal part are marked but not produced. Upon the whole the form of these pedicellariæ, however, is not very constant. Tridentate pedicellariæ are found; they are like those of *bothryoides*, and the same holds good for the ophicephalous ones; the triphyllous pedicellariæ (Pl. VI. Fig. 44) have the blade more widened than in *bothryoides*.

The colour is very variable; the test may be uniformly gray, with some indistinct white spots, or white with reddish spots or even quite white; sometimes it is violet or red. The spines are uniformly whitish, reddish or violet or with a pair of faint reddish bands.

This species is the „*Temuopleurus bothryoides*“ of BELL¹⁾ from Macclesfield Bank. I have also seen specimens from Hongkong (Hamburg Museum), Torres Strait (Haddon) and from the „Siboga“-Stations 43, 99, 164, 258 and 315 (?). It is evidently closely related to *Pl. bothryoides* and perhaps ought to be regarded only as a variety of that species. But in any case it must be kept as a distinct form; whether it then be regarded as a separate species or only as a variety, is of very little importance. — From *siamensis*, to which it may also have considerable resemblance, it is distinguished by the transverse line of the genital plates and by the tubercles forming horizontal rows; the latter feature, however, is of course not seen in very small specimens. — It is a rather large species, though, probably, it does not reach the size of *bothryoides*.

The number of species of the genus *Pleurechinus* having thus been increased from 2 (*Pl. bothryoides* and *ruber*, the species *variabilis* Döderl. not really belonging to this genus) to 7, it will be very useful to give an analytical table of the species.

¹⁾ Echinoderms of Macclesfield Bank. p. 410.

Table of the species of *Pleureechinus*.

1. Only five buccal plates and tube feet; anal opening central, no anal plate. Spines thorny. Globiferous pedicellariæ with a large unpaired lateral tooth..... *Pl. Döderleini* Mrtsn.
 Ten buccal plates and tentacles. A more or less distinct anal plate. Spines smooth or thorny. Globiferous pedicellariæ with 1—1 lateral teeth or with only a rounded knob on one or either side below the endtooth..... 2.
2. Pits small; spines smooth. Globiferous pedicellariæ without lateral teeth, the blade very short..... 3.
 Pits large, reaching to the base of the primary tubercles. Globiferous pedicellariæ without teeth or with 1—1 lateral teeth; the blade not very short..... 4.
3. Pores rather large; ambulacral plates lower than the interambulacral ones, their number being somewhat larger. Colour of test red; the spines red with white bands. Genital plates without transverse line..... *Pl. ruber* Döderl.
 Pores very small; ambulacral plates as high as the interambulacral ones, their number being the same. Colour of test gray; the spines reddish at the base, mostly with a small dark band in the outer part. The outer part of the genital plates separated from the inner part by a sinuous line..... *Pl. variegatus* Mrtsn.
4. Globiferous pedicellariæ with 1—1 distinct lateral teeth; spines smooth, with intensely red bands. Test uniformly dark coloured..... *Pl. bothryoides* Agass.
 Globiferous pedicellariæ without lateral teeth, only a rounded knob on one or both sides below the endtooth. 5.
5. Spines thorny, at least the secondary ones, not swollen at the point *Pl. scillæ* (Maz.). 6.
 Spines smooth, the primary ones swollen at the point.
6. The genital plates divided by a transverse line into an outer and inner part; the secondary tubercles arranged in a horizontal row *Pl. maculatus* Mrtsn.
 The genital plates not divided into two parts by a transverse line; the secondary tubercles not forming horizontal series *Pl. siamensis* Mrtsn.

The validity of the genus *Pleurechinus* has been somewhat disputed. AGASSIZ (Rev. of Ech.) regards it as a subgenus of *Temnopleurus*, and this is also the position accorded to it by DUNCAN¹⁾ in his „Revision of the Genera and great Groups of the Echinoidea“ (p. 107). BELL (Echinodermata. „Alert“ p. 119) makes it synonymous with *Temnopleurus*, whereas DÖDERLEIN (Echinoidea von Amboina — Semon's Reisen) recognizes the validity of a genus or, at least, subgenus *Pleurechinus*, distinguished „durch ihre auffallend kugelig gerundete, meist hohe Schale, durch die fehlende Crenulierung ihrer Hauptwarzen, besonders aber dadurch, dass auf der Buccal- wie Apicalseite die Ambulacral- und Interambulacralplatten regelmässige Horizontalreihen kleiner Hauptwarzen tragen, endlich durch ihre sehr kurzen und überall etwa gleich langen Stacheln“. — „Die Apicalseite ist ferner bei *Pleurechinus* der Buccalseite sehr ähnlich, bei *Temnopleurus* sind beide Seiten sehr verschieden“. Through the comparatively large number of species made known in this paper, the characters pointed out by DÖDERLEIN as distinctive of the genus are modified to some extent. The form of the test is low in *siamensis* and *scillæ*, being very different from such species as *bothryoides* and *maculatus*; no generic character is then found in the form of the test. The primary and secondary tubercles do not form transverse series in *Döderleini*, *siamensis* and *scillæ*. This feature must accordingly also be left out of consideration as a generic character. The absence of crenulation is a more general feature, but not quite exclusive, the tubercles being rather distinctly crenulate in larger specimens of *variegatus*; this is, however, evidently a very important character uniting this group of species. The large pits would be another excellent character, were it not for the two species *ruber* and *variegatus*, where they are rather small. It is also to be remarked that there is a covering membrane round the edge of the pits, leaving only a smaller opening in the middle — but this is not found in *variegatus* (and, probably, not in *ruber*). The uniform character of the spines and of the two sides of the test holds good. No generic character is found in the pedicellariæ. It is thus rather difficult to give a good definition of the genus *Pleurechinus*. If the species *ruber* and *variegatus* were removed from the genus, the large pits bordered by a membrane would give an excellent character for the other species; and if *Döderleini* were removed also, the rest of the species would form a somewhat more close group, though not even then a uniform group, the species *bothryoides* and *maculatus* on the one hand, *siamensis* and *scillæ* on the other hand forming special groups. It seems, however, unnecessary to make these groups each a separate genus. I prefer to leave them all in the genus *Pleurechinus*, which is, I think, sufficiently distinguished from *Temnopleurus* by its noncrenulate tubercles (in spite of the large specimens of *variegatus*) the uniform size of the spines and the uniform aspect of both sides of the test. To regard it as a mere subgenus of *Temnopleurus* (or even synonymous with that

¹⁾ Comp. also DUNCAN's paper: On the genus *Pleurechinus*, L. Agass., its classificatory position and alliances. J. Linn. Soc. XVI. 1882. p. 447.

genus) I find no reason, especially now that it has been shown to contain a much larger number of species than the genus *Temnopleurus* itself.

„*Pleurechinus*“ *variabilis* Döderlein differs very markedly from all the *Pleurechinus*-species mentioned or described above in having in the interambulacra two large shallow depressions along each horizontal suture besides the usual ones at the inner and outer end of the suture, which are, however, only low depressions, not deep pits as in the other *Pleurechinus*-species; in the ambulacra there is one such intermediate groove. (Comp. the description given by DÖDERLEIN: Seeigel von Japan u. den Liu-Kiu-Inseln. p. 18.) This species in fact completely agrees with the genus *Opechinus* Desor¹⁾, and there can certainly be no doubt that it must be referred to that genus. *Opechinus* is most nearly related to the genus *Temnechinus* Forbes, both being distinguished by having only low depressions in the sutures, but no true, deep pits, undermining the plates, as are found in *Pleurechinus*, *Temnopleurus*, *Salmacis* etc. To DUNCAN is due the merit of having pointed out this important difference²⁾. The „*Pl.*“ *variabilis* is thus really very different from *Pleurechinus*. To be sure it is said in DÖDERLEIN's description of this species that the grooves at the end of the sutures „gewöhnlich sehr seicht, manchmal auch scharf und tief erscheinen“ (p. 19), an assertion which is in direct opposition to the primary importance of the difference between true and false pits. But DÖDERLEIN is wrong here, having confounded specimens of *Pleurechinus variegatus* with the true *variabilis* (which has evidently also caused the name *variabilis*), as I can state, Prof. DÖDERLEIN having most kindly placed his material at my disposal. The specimen figured by Döderlein (Taf. LXI. Fig. 5 a—b) as *Pleurech. variabilis* juv. is really *Pleurech. variegatus*.

DUNCAN (On the genus *Pleurechinus*. p. 449) makes *Opechinus* a synonym of *Temnechinus* Forb., „as its essential character, never generic, is due to chances of growth of ornamentation“. For this assertion there is no reliable evidence. In DUNCAN & SLADEN's Monograph of the Tertiary Echinoidea of Kachh and Kattywar (Palæontologia Indica. Ser. XIV. 1883) it is stated for *Temnechinus* (*Opechinus*) *Rousseaui* that „the fossettes are not seen in the very young form; and in some large specimens there is so little trace of them that they resemble species of *Salmacis*, and the plates are then not bevelled“ (p. 55). But there is no proof at all that these specimens are really the same species as those with the fossettes well developed; this cannot be made out with certainty in fossil specimens, where the characters found in pedicellariæ and spines etc. have been lost. I quite agree with GREGORY (British Fossil Cænozoic Echinoidea. Proc. Geologists Assoc. XII. 1891. p. 29) that *Opechinus* must be maintained as a distinct genus besides *Temnechinus*, the Crag-

¹⁾ In Rev. of Ech. p. 465 AGASSIZ says the same of *Pleurechinus bothryoides*, which would have been true if his description of that species had been correct. But *Pl. bothryoides* has really only two pits in each horizontal suture, and it does not correspond to *Opechinus*.

²⁾ On some Points in the Morphology of the test of the Temnopleuridæ. J. Linn. Soc. XVI. 1881.

species and the Oriental species forming two very well defined groups, the one without, the other with intermediate depressions. „The differences between the two groups of species may be only due to the disposition of the raised epistromal ribs, but these affect so materially the whole aspect of the tests, and the epistroma plays so prominent a part in the classification of the Glyphocyphinae that it is convenient to express the differences in this way“. „*Pl.*“ *variabilis* is then a recent representative of the genus *Opechinus*, so well represented in the Tertiary of India by the species: *Rousseaui* d'Arch., *Hookeri* d'Arch., *costatus* d'Arch., *tuberculosis* d'Arch., *Valenciennesi* d'Arch. (this is the first named but, unfortunately, the least typical species, the intermediate grooves not being distinctly separated from the angular ones), *percultus* Desor, *affinis* Dunc. & Slad. (but not *Temnech. stellulatus* Dunc. & Slad. nor *Gajensis* Dunc. & Slad., which have no sutural depressions, but a strongly reticulated surface; they are probably nearly related to *Genocidaris* and *Trigonocidaris*).

POMEL (Op. cit. p. 85) makes the species *costatus* d'Arch. the type of the genus *Opechinus*, referring the species *Valenciennesi*, *Rousseaui*, *Hookeri*, *tuberculosis* and *percultus* to the genus *Pleurechinus*. — This wrong representation of the two genera evidently is caused by the fault in the description of *Pl. bothryoides* of AGASSIZ pointed out above. To separate the species *costatus* from the other species with intermediate fossettes on account only of its having a depression in the middle of the interambulacral plate in succession to the series of depressions along the opposite suture seems rather absurd, the more so as in other species the median sutural depression may proceed on the median point of the opposite interambulacral plate (in *O. spectabilis* f. i.).

It is interesting to note the assertion of DESOR with regard to this genus (Synopsis des Échinides fossiles. p. 107) that „il en existe des espèces vivantes“; it thus seems that he has seen specimens of some recent form of *Opechinus*; likewise the description of *Pl. bothryoides* in „Rev. of Ech.“ might seem to indicate, that AGASSIZ has seen such a specimen (comp. above p. 83). In the „Challenger“-Echinoidea (p. 108) AGASSIZ further says of some small specimens of *Pleurechinus bothryoides* (those specimens, I suppose, which are not *bothryoides* but, probably, *variegatus*): „they show clearly that we may expect to find in the China Seas a species of *Temnopleurus* still retaining the principal features so characteristic of some of the nummulitic species of India, figured by d'Archiac and Haime“ (*Temnopleurus Valenciennesi*). I am unable to understand how these specimens can show this, since all the „Challenger“-specimens of *Pl. bothryoides* are, in any case, true *Pleurechinus*-species with only two pits in each suture. But it is a very curious thing too that among the „Challenger“-Echinids AGASSIZ really had a species of that interesting group, and even a large, beautiful and well preserved specimen; but he cannot have examined it very exactly, having determined it as *Temnopleurus Hardwickii* (St. 192). Through the kindness of Prof. BELL I have been

allowed to examine this most interesting form, which is described below as *Opechinus spectabilis* n. sp. Thus we know now two living representatives of this very remarkable group.

Opechinus variabilis (Döderl.). To the description of this species may be added some few remarks. The spines are smooth, not swollen at the point, ending in a central thorn with a circle of small thorns at its base. The globiferous pedicellariæ (Pl. VI. Fig. 27. Pl. VII. Fig. 2) have no lateral teeth; the outer corners of the basal part are marked and more or less produced; the blade is quite open or with a single transverse beam. The ophicephalous and triphyllous pedicellariæ (Pl. VII. Fig. 7, 49) do not present any remarkable characters. Slender bihamate spicules are found in the tubefeet and in the head of the globiferous pedicellariæ. De MEIJERE („Siboga“-Echinoidea. p. 79) mentions some specimens of „*Pleurechinus*“ *variabilis*. Since he has sent me these specimens together with all his specimens of „*Pleurechinus bothryoides*“, I can state that those (two) from St. 98 are quite different from *O. variabilis*. They evidently belong to an undescribed species of the genus *Genocidaris*. The specimen from St. 105 is a true *Opechinus* and probably *O. variabilis*, though it has comparatively fewer tubercles than the type-specimen.

Opechinus spectabilis n. sp. (Pl. I. Fig. 15). The test is low, the abactinal side somewhat conical, the actinal side flat. (Diameter 30 mm., height 16 mm.) The primary tubercles are noncrenulate, of about equal size in both areas, diminishing a little in size towards the apical system. In the ambulacra the secondary tubercles form a distinct vertical series inside the primary series. Numerous small tubercles are scattered irregularly on the plates inside and above the primary tubercle, which is placed close to the pores. Along the median line there is a smooth space. Besides the depression at the median end of the suture there is, at the ambitus, another smaller, intermediate depression opposite to the space between the primary and the large secondary tubercle. This intermediate depression appears at about the 6th plate from above; below the ambitus both depressions soon disappear. The pores are disposed in an almost straight series close to the edge of the area; the interporiferous zone is much broader than the poriferous. The ambulacral plates are a little lower than the interambulacral ones, their number being 19 against 16—17 interambulacral plates.

In the interambulacra the secondary tubercles form at the ambitus two vertical series inside and one outside the primary tubercles, almost as large as the primary ones. Below the ambitus the innermost series first disappears, the two other series being distinct almost to the peristome. Both these series likewise are distinct almost to the apical system, whereas the innermost series only appears at the 6th—7th plate from above. All these tubercles likewise form a distinct horizontal series on each plate. Small tubercles cover the rest of the plates, forming a close circle around each larger tubercle. The median line is naked. At the ambitus there are no less than 6 depressions in each horizontal suture, the two angular

and 4 intermediate ones. The largest are those at each side of the primary tubercle; from there the depressions decrease in size towards the angles. Outside the large grooves there is only one, the angular groove, inside the large ones there are two intermediate grooves and the angular one. Towards the apical system the grooves nearest the angular ones by and by disappear, uniting with the angular ones. On the 4—5 uppermost plates there are only two grooves in each horizontal suture; from the 5th—6th the two large grooves at the primary tubercle become separated off from the angular ones. Below the ambitus all the intermediate grooves disappear very soon, whereas the angular ones may be traced almost to the peristome. The inner angular groove is continued over the suture upon the median corner of the opposite plate.

The apical area, 8.5 mm. in diameter, is regular, no ocular plate reaching the periproct. The genital opening is at the outer edge of the plate, and there is a small genital papilla. A circle of tubercles is found at the inner edge of the genital plates. The ocular plates are covered by numerous small tubercles. The anal area (4.5 mm.) is covered by numerous small, irregular plates without tubercles. No distinct anal plate. The anal opening is central.

The buccal membrane has only some few small plates in the inner edge besides the buccal plates, which are equally distant from the edge. Otherwise the buccal membrane contains numerous slender, bihamate spicules, which are often arranged in thick bundles, mostly forming rings (Pl. V. Fig. 21). — The spines are very short, the longest being scarcely 5 mm., $\frac{1}{6}$ of the diameter of test. They are greenish, dark at the base and faintly ringed; they are smooth, ending in a rather large central thorn with a circle of small thorns at its base; the point is not swollen. The actinal ones are a little widened, flat and curved.

The globiferous pedicellariæ (Pl. VII. Figs. 18, 19) have no lateral teeth, but a rather large rounded knob on each side below the endtooth; the blade is rather elongate, the outer corners of the basal part rounded, not produced. Tridentate pedicellariæ occur in this species (Pl. VI. Fig. 42. Pl. VII. Fig. 45); they are rather small (c. 0.5 mm. head). The valves are broad, with a little meshwork at the bottom of the blade. The edge has some coarse sinuations in the outer part and is otherwise finely serrate in the whole length. The valves join in their whole length. Below the basal part there is a well developed semicircular arc, as in the ophicephalous pedicellariæ, a very interesting, though not unique, feature. The ophicephalous pedicellariæ are like those of *O. variabilis*; the triphyllous ones (Pl. VII. Fig. 27) have the blade somewhat widened. — Bihamate spicules are found in the tube feet, though not very numerous, and at the base of the spines. — The colour of the test is greenish-gray, with large, irregular spots at the ambitus; the actinal surface is white.

The only specimen known of this most interesting species was taken by the „Challenger“ at the Kei-Islands (New Guinea), Lat. 5° 42' S., long. 132° 25' E.

129 fathoms, mud. (St. 192.) As mentioned above it is named *Temnopleurus Hardwickii* in the „Chall.“ Echinoidea p. 107.

The relation between the two recent species of *Opechinus* thus far made known and the fossil species is not to be made out with certainty, as the latter are known from the tests alone; but it seems that *O. variabilis* is most nearly allied to *O. Rousseaui*, whereas *O. spectabilis* differs from all the fossil species known (to me) in the number of grooves, being thus the most specialized form of the genus. Otherwise it has most likeness to *O. Rousseaui*, which species may then perhaps be the ancestor of the recent species.

I may here take the occasion to give some notes on the other *Temnopleurids*, not mentioned above.

Salmacopsis olivacea Döderlein. The globiferous pedicellariæ (Pl. VI. Figs. 25, 30) have no lateral teeth, only a rounded knob on one side below the endtooth; the outer corners of the basal part are rounded, a little produced. The ophicephalous pedicellariæ are like those of *Opech. variabilis*; the triphyllous ones (Pl. VII. Fig. 23) have a few serrations in the edge of the lower part of the blade (always?). The spicules are bihamate, very scarce in the tube feet; in the stalk of the globiferous pedicellariæ some spicules may occur. The buccal membrane is quite naked except the buccal plates and some bihamate spicules. The genital plates show the same peculiar feature as *Pleurech. variegatus*, the outer part of the genital plates being apparently separated off from the inner part by a transverse (straight) line. The primary spines are smooth, ending in a mostly rather long central thorn, surrounded at its base by a circle of smaller thorns. The secondary spines are faintly thorny, a little swollen at the point; the central thorn is not prominent above those of the outer circle. — *Salmacopsis pulchellinus* Yoshiwara I have not seen. — The genus *Salmacopsis* evidently has the same relation to *Salmacis* as *Pleurechinus* has to *Temnopleurus*.

Mespilia globulus (L.). The globiferous pedicellariæ (Pl. VII. Figs. 16, 22) are exceedingly characteristic; there are 2—5 lateral teeth on either side of the blade, the upper ones, which are directed outwards, being almost as long as the endtooth; the lower ones are mostly smaller and are gradually turned inwards. The blade is open; the basal corners not produced. These (small) pedicellariæ occur in immense numbers on the naked parts of the test together with a few triphyllous ones. Tridentate pedicellariæ I have only found in the type specimen of *M. Whitmæi* (comp. below); they are exceedingly small and simple, leafshaped (Pl. VII. Fig. 47); the ophicephalous pedicellariæ (Pl. VII. Fig. 33) have the valves narrowed in the middle. The triphyllous pedicellariæ (Pl. VI. Fig. 17) are very small, with the apophysis incompletely developed; generally some of the holes are elongate. In „Rev. of Ech.“ Pl. XXXVIII. Fig. 22 AGASSIZ figures an „interambulacral abactinal pedicellaria“ of *M. globulus*, which looks quite problematic. I have never seen anything like it; if it represents a globiferous pedicellaria of this species, the figure is, as will be seen

by comparing it with the figures given here, very bad. — The buccal membrane contains the usual ring of plates in the oral edge; otherwise no plates, but some bihamate spicules are found. In the tubefeet spicules (bihamate) are very scarce. The spines have no central thorn in the point; they are not swollen. In larger specimens the pores are rather distant from the edge of the area.

In his most severe (but not too severe) criticism of PERBIER's work on the pedicellariæ (Rev. of Ech. p. 661) AGASSIZ says: „no mention even is made of GRUBE's suggestions as to the pedicellariæ of these interesting genera“ (*Temnopleurus*, *Salmacis* etc.). The only thing I can find in the writings of GRUBE concerning the pedicellariæ of Temnopleurids is the following notice: „Bei der Gattung *Mespilia* sind auf der Rückenseite die Mittelpartien der Ambulacral- und Interambulacralfelder stachelfrei und erscheinen bei trocknen Schalen wie fein chagriniert; bei wohl-erhaltenen Weingeistexemplaren sehen die Stellen so aus, als wären sie mit Filz oder Schimmel bekleidet, und die mikroskopische Untersuchung dieses Überzuges zeigt, dass derselbe aus lauter Pedicellarien von der Form der *gemmatae* besteht, während Pedicellarien mit schlanken Armen spärlicher zwischen den Stacheln vorkommen“¹⁾. According to the manner in which AGASSIZ expresses the fact of the omission it can scarcely be this little notice which is meant. I am sorry to be ignorant of something of importance regarding the pedicellariæ; but it is very unfortunate that AGASSIZ so very often refers to his own and other authors writings without citing the place or even the work in which the observations are found. It causes his fellow workers very much unnecessary and, unfortunately, often lost labour to find out the references.

Mespilia Whitmai Bell²⁾ does not differ from *globulus* as regards pedicellariæ and spines (I have examined the type-specimen). As distinguishing characters are pointed out by BELL the well-marked gill-cuts, the narrow median ambulacral space and more numerous tubercles, and the more spatulate character of the free end of the radius. None of these characters are reliable. Two specimens (from „the South-Sea“, 20—25 mm. in diameter) preserved in the Museum of Copenhagen, which are quite similar to the type-specimen of *M. Whitmai*, have a very narrow median bare space in the ambulacra and more tubercles than usual, but the actinal cuts are small. The character in the radius (rotula) is scarcely of any value either; in one specimen I find two of the rotulæ spatulate, the three others distinctly bifid. Upon the whole I do not find the form of these inner structures (auriculæ, dental apparatus) so constant as to be relied upon for specific characters. When BELL says that the number of pores of the outer row „seems to be about

¹⁾ Über diejenigen Gattungen der regelmässigen Seeigel, welche an den Grenzen der Täfelchen sowohl auf den Ambulacral- als Interambulacralfeldern Eindrücke zeigen. Jahresber. Schles. Gesellsch. Vaterl. Cultur. XLIII. 1865. p. 62.

²⁾ Description of a new species of the genus *Mespilia*. Proc. Zool. Soc. 1881. p. 433.

double those in the inner row“ it must be a lapsus calami; the inverted order prevails.

While *M. Whitnei* thus certainly must be withdrawn as a synonym only of *M. globulus*, some specimens in the British Museum from Macclesfield Bank, named *M. globulus*, will perhaps prove to be another species. They present the curious feature of the calcareous substance in the pedicellariæ being of a beautiful red colour (especially the ophicephalous ones); but otherwise the pedicellariæ do not present differences from those of *M. globulus*. Only the naked interambulacral spaces are dark, the rest of the test is beautifully red coloured; the spines are distinctly red ringed. — Possibly they belong to *M. levituberculata* Yoshiwara¹⁾, for which species it is pointed out that the pedicellariæ are brown: however they do not accord very well with the (insufficient) description of that species, so that I shall not try to decide whether they really belong to it having seen no authentic specimen of *M. levituberculata*. YOSHIWARA points out as the most important character of *M. levituberculata* that its primary and secondary tubercles are very small, not perforated or crenulated „thus differing from any other species of *Mespilia*“. It need scarcely be remarked that no Temnopleurid at all, nor, indeed, any Echinid of the Tribus *Echinina* has perforate tubercles; and crenulate tubercles do not occur in the only other known species of *Mespilia*, *M. globulus*.

Microcyphus maculatus Agass. The globiferous pedicellariæ (Pl. VI. Fig. 19. Pl. VII. Fig. 20) are rather large and have no lateral teeth; the outer corners of the basal part are rounded, and may be a little produced. The valves of the ophicephalous pedicellariæ (Pl. VII. Fig. 31) are narrowed in the middle; the triphyllous pedicellariæ are very similar to those of *Salmacopsis olivacea* (Pl. VII. Fig. 23), but the edge is quite smooth. Tridentate pedicellariæ I have not found. The spicules of the tubefeet (bihamate) are very few in number. The buccal membrane has a ring of small plates in the oral edge, otherwise it is naked, with a few bihamate spicules. Ophicephalous and triphyllous pedicellariæ may occur on the buccal plates. The spines, primary and secondary, end in a large central thorn without small thorns at its base (Pl. II. Figs. 23, 28).

It may well be regarded as doubtful, whether *M. Rousseaui* Agass. (the form figured in „Rev. of Ech.“ Pl. VIII. a. Fig. 8) is really synonymous with *M. maculatus*, as maintained by AGASSIZ. In any case the spines and pedicellariæ of this form must be examined, before we can say with certainty, if they be identical or not. (The type-specimen is a naked test.) A priori it seems not very probable that such changes as seen by comparing the figures 8 and 9 in Pl. VIII. a. of „Rev. of Ech.“ do really occur in the same species. Also the type of *Anthechinus roseus* A. Ag. might well deserve a renewed examination. The perfectly smooth genital plates, the spines on the anal plates and the „exceedingly slender“ spines do not agree very well with *M. maculatus* to which species AGASSIZ refers it as a synonym.

¹⁾ Preliminary notice of new Japanese Echinoids. Annot. Zool. Japon. II. 1898. p. 58.

In the collection of Echini from the Hamburg Museum I found a small specimen of a *Microcyphus* (from Tor, on the coast of Sinai; Dr. Hartmeyer, 1901) which is distinguished from the typical *M. maculatus* by its redbrown, ringed spines (with 2—4 narrow light bands) and its redbrown test. Also the ophicephalous pedicellariæ are reddish. Otherwise it agrees with *maculatus*. Probably this form will prove to be a distinct variety of *maculatus* or perhaps a separate species. As, however, it may possibly prove identical with *M. Rousseaui*, I shall not propose any name for it, but be content with drawing attention to this form.

Microcyphus zigzag Agass. The globiferous pedicellariæ are very small and have mostly a large lateral tooth; rather often, however, this lateral tooth is not developed or quite rudimentary. The blade is flat, not in the usual form of a closed tube; upon the whole they are like those figured of the new species *M. annulatus*, to which figures reference may be made (Pl. VI. Figs. 29, 31). The valves of the ophicephalous pedicellariæ are short and broad, not narrowed in the middle; they are like those of *M. annulatus* (Pl. VI. Fig. 15). Triphyllous pedicellariæ like those of *M. maculatus*; tridentate pedicellariæ not found. Rather numerous small bihamate spicules in the tubefeet and sometimes in the globiferous pedicellariæ. The buccal membrane contains no plates besides the usual ring of small plates in the oral edge. A few bihamate spicules may also be found in the buccal membrane; no pedicellariæ on the buccal plates. The spines (Pl. II. Figs. 20, 25, 26) end abruptly in a not very long central thorn, mostly without a distinct circle of small thorns at its base. The secondary spines are a little widened at the point, the central thorn being little conspicuous. The primary spines are of a dark red colour, the secondary ones faintly reddish.

Of this species I found three specimens in the British Museum from Port Philip, named *Amblypneustes ovum* (see below); they agree exactly with the figures in „Rev. of Ech.“ Pl. VIII. c. 11—13; the largest specimen (25 mm. diameter, 23 mm. high) in particular is very like the large specimen figured by AGASSIZ. Of the two other specimens one is 12 mm. in diameter, 10 mm. high, the other 11 mm. in diameter, 9.5 mm. high. — Unfortunately the type-specimen in the Paris-Museum has only some ophicephalous pedicellariæ left; they agree with those of *M. annulatus*. In his „Notes on the Echinoderms collected at Port Philip by Mr. J. B. Wilson“¹⁾. BELL mentions a small specimen of *Microcyphus zigzag* „of a most beautiful rosy colour“. This specimen I have examined; it differs from *M. zigzag* in several respects. The form of the test is alike, but the tuberculation is a little poorer than in *M. zigzag* of a corresponding size; thus in *M. zigzag* there are two rather large secondary tubercles inside the primary one in the interambulacra, these three tubercles together forming a horizontal series. In this specimen there is only one such tubercle inside the primary one. The naked spaces are somewhat

¹⁾ Ann. Nat. Hist. 6. Ser. II. 1888. p. 405.

larger than in specimens of *M. zigzag* of a corresponding size. The globiferous pedicellariæ (Pl. VI. Fig. 24. Pl. VII. Fig. 38) have no lateral teeth, but as they occur in *M. zigzag* both with and without an unpaired lateral tooth, it may perhaps be the case here also. The other pedicellariæ are like those of *M. zigzag*. The secondary spines are much widened at the point and without a distinct central thorn; the primary spines are like those of *M. zigzag*, but they are very faintly red coloured. No plates in the buccal membrane except the ring at the inner edge and the buccal plates. — The characters pointed out here are certainly not very marked, but the different coloration of the test and spines makes this form look so different from *M. zigzag* with its dark coloured naked spaces that it must certainly be separated from that species. Perhaps it ought only to be regarded as a variety of *M. zigzag*; but from the material at hand I must regard it as a distinct species, for which I propose the name *Microcyphus elegans* n. sp. I have seen one more specimen of this species in the British Museum, from the same locality; it was named *Amblypneustes ovum* (comp. below). The two specimens measure 12·5 mm. in diameter, one 11·5, the other 10·5 mm. in height.

At least one more species of *Microcyphus* exists. A specimen named *Microcyphus zigzag*, from „Challenger“ St. 162 (Bass Strait, 40 fathoms) proves to be quite different from both *M. zigzag* and *elegans* and must certainly be made the type of a new species. (As regards the specimens from St. 161, Port Philip, the red banded spines in one of them show it to belong to the same species as the example from St. 162. My notes upon the rest of them are, however, insufficient to settle their position). The test is high as in the two other species, but it presents the very interesting feature of being elongate, the longitudinal axis passing through the ocular plate to the right of the madreporic plate, as seen from above. The short diameter is 12·8 mm., the long diameter 14·8 mm. (height 12 mm.), the elongation being thus very distinct. Now, of course, this cannot be concluded with certainty from the one specimen examined to be a constant character of this species; it may possibly be an abnormality. But the specimen otherwise looks quite normal, and it seems probable that this is really a specific character, and one of great interest as the only known example of obliquity of test among the *Temnopleuridæ*. The naked median spaces are very large, especially the interambulacral ones, comprising almost the inner half of the plates. The tuberculation is much more sparse than in *M. zigzag* (specimens of equal size being compared); the interambulacral plates bear inside the primary tubercle (at the ambitus) only one secondary tubercle and two or three miliary ones, whereas in *M. zigzag* there are two (in large specimens three) large secondary tubercles inside the primary one, all together forming a distinct horizontal series. Close above the primary tubercle, a little to the outside of it, there is another large tubercle, almost as large as the primary one; otherwise only quite small tubercles are found outside the primary one. In *M. zigzag* a corresponding tubercle can be

pointed out, but it is much less conspicuous; in the latter species also some larger tubercles are found outside the primary one in larger specimens, but this will perhaps also be the case in larger specimens of the new species. In the ambulacra there is a larger secondary tubercle, half as large as the primary one, midway between the inner edge and the primary tubercle; in *M. zigzag* there is a large tubercle, almost as large as the primary one, rather close to the inner corner of the plate. No pits are visible; neither in *M. elegans* nor in the specimens examined of *M. zigzag* were pits to be seen. The apical area is comparatively large (5 mm.), prominent and almost naked; only 2--3 small tubercles are found on the middle of each genital plate (in *M. zigzag* they are almost wholly covered by tubercles). Anal opening central. The buccal membrane contains, besides the usual ring of plates in the oral edge, some small, more or less thorny plates (Pl. V. Fig. 17) between and outside the buccal plates; also the edge of the buccal plates may be somewhat thorny; rather numerous bihamate spicules are also found in the buccal membrane. The spines end in a not very long, central thorn, with a circle of small thorns at its base; the secondary spines are a little widened in the point, the central thorn being little conspicuous. The globiferous pedicellariæ (Pl. VI. Figs. 29, 31) are very small and have a rather large lateral tooth; the blade is flat, not in the usual form of a tube. The valves of the ophicephalous pedicellariæ (Pl. VI. Fig. 15) are short and broad, not narrowed in the middle, though not always so short as the figured one. The triphyllous pedicellariæ are like those of *M. maculatus*; tridentate pedicellariæ are not found. — The colour of the test is pale brownish, the naked spaces being white. The primary spines are white, with a broad red band in the lower part. — For this very distinct species I propose the name *Microcyphus annulatus* n. sp.

Among some specimens in the British Museum from Port Philip, named *Amblypneustes ovum* (see below) there is a small specimen, which probably belongs to this species. The short axis is 7.5 mm., the long 8 mm. (height 6 mm.), the obliquity thus being already rather distinct in this very small specimen — an additional fact tending to show the elongation to be a normal feature of this species. The colour of the test is darker, the naked spaces not white, though paler in colour than the tuberculated part. The red band on the spines is very intense in colour. Otherwise it agrees with the specimen described above.

AGASSIZ says (Rev. of Ech. p. 470) with regard to *Microcyphus zigzag* „this species is interesting as forming a link between *Microcyphus* and *Amblypneustes*. It has the structural features of the former and the facies of the latter“. This is quite true. These two genera are indeed so very closely related that the only real distinguishing character, which seems to be found, is the naked median space in *Microcyphus*. Now this feature is very slightly developed in *M. zigzag* (which species also in form and size is so very like a typical *Amblypneustes*), and in *Amblypneustes* there may also be an indication of a bare median space. It will, however, certainly be right to maintain the two genera, which both contain a number of

species, whose extreme forms: *Microcyphus maculatus* and *Amblypneustes pallidus* (or any other *Amblypneustes*-species) differ so much that it would be impossible to unite them in the same genus.

The genera *Amblypneustes* and *Holopneustes* are notorious for their difficulty. A rich material will be needed for definitely working out the rather numerous species; such is, however, not yet found in the collections of the different Museums. By far the largest number of the preserved specimens are naked tests, which do not afford sufficient characters for the distinction of the species. Especially it is an unfortunate circumstance that the type-specimens are naked tests, if they are found at all, which is not the case with all of them. As I have examined the specimens preserved in the British Museum and the Paris-Museum, and as the Copenhagen-Museum is comparatively rich in these forms, I am able, in spite of the unfortunate circumstances pointed out above, to make some remarks on this subject, which, I think, will not prove valueless.

First an important character may be pointed out, by which the genera *Amblypneustes* and *Holopneustes* are easily distinguished, viz. that in all the *Amblypneustes*-species (except *A. pentagonus* — see below) there is a primary tubercle on all the ambulacral plates; in the *Holopneustes*-species a primary tubercle is found only on every second or third ambulacral plate, or even more irregularly. By this character even quite small specimens, in which the pores are placed in regular arcs of three as in *Amblypneustes*, may be safely distinguished as belonging to *Holopneustes*; in a specimen of 10 mm. diameter I find the alternation of the primary tubercles quite distinct. — It may be remarked that in large specimens of *Holopneustes* several of the ambulacral plates do not reach the median line of the ambulacral area, thus looking like small primaries. In reality they are compound plates; the number of tube feet has been so exaggerated that the plates have become very low and almost rudimentary to make room for all the feet (Comp. „Ingolf“-Echinoidea. I. p. 132–3). GREGORY¹⁾ has pointed out the same feature in *Tripneustes*, remarking that, in fact, here are more than two series of ambulacral plates, as in the *Palæechinoidea*. This feature is much more distinct in *Holopneustes*. Of course it is really something very different from the pluriseriate ambulacra of the *Palæechinids*, as in the latter all the ambulacral plates are primaries, whereas in *Tripneustes* and *Holopneustes* they are very modified compound plates.

Among the species referred to *Amblypneustes* one has already been removed from that genus by DUNCAN (Revision p. 113) and made the type of a separate genus, *Goniopneustes*. (AGASSIZ himself supposes („Rev. of Ech.“ p. 483) that it will eventually form a separate genus between *Satmacis* and *Amblypneustes*.) To the characters pointed out by AGASSIZ and DUNCAN I may add one, which is seen in the figures (photographs) of the species given by AGASSIZ (Rev. of Ech.“ Pl. VIII. c. 7–8) viz. that only every second or third ambulacral plate has a primary tubercle. Pedicellariæ

¹⁾ In RAY LANKESTERS Treatise on Zoology. III. 1900, p. 299.

(and spicules) unfortunately are unknown. The validity of this genus can scarcely be doubted; but it seems certain, in any case, that it is very nearly related to *Holopneustes*, with which genus it agrees in the character of the ambulacra, as opposed to all other Temnopleurids (except *Salmacis dussumieri*).

Amblypneustes formosus Val. To the description in „Rev. of Ech.“ p. 479 the following remarks may be added. The globiferous pedicellariæ (Pl. VI. Fig. 37. Pl. VII. Fig. 4) are small, with an unpaired lateral tooth (which may, however, be more or less rudimentary); the basal corners not produced. The ophicephalous pedicellariæ (Pl. VI. Fig. 9) have short and broad valves; the triphyllous pedicellariæ (Pl. VII. Fig. 13) have the blade rather elongate and narrow. Tridentate pedicellariæ I have not seen. — The spicules (bihamate) are rather numerous in the tube feet. The buccal membrane contains the usual ring of plates in the oral edge, otherwise it is naked — excepting the buccal plates, of course — but with numerous bihamate spicules. The gills contain some few of the common irregular plates and numerous bihamate spicules. The primary spines (Fig. 9) are almost equally thick in their whole length, ending quite abruptly in a little central peak surrounded by small thorns at its base; sometimes the central thorn is not seen. The point is not swollen (Pl. II. Fig. 27). The secondary spines are more or less swollen at the point; they may have a distinct central thorn like the primary ones, or the point may be covered by very small thorns, without a larger central one.

Amblypneustes ovum (Lamk.) is most nearly related to *A. formosus*, with which it agrees in having slender primary spines, not thickened at the point. The secondary spines are thickened at the point, without a central thorn. The globiferous pedicellariæ are like those of *A. formosus*. The ophicephalous pedicellariæ are very variable in shape, the valves being short and broad like that figured for *A. formosus* or very elongate (Pl. VII. Fig. 50), and between these extremes all transitional forms are found. Tridentate pedicellariæ occur in this species; they are rather small (c. 0.8 mm., head); the valves are simply leafshaped with rather much meshwork in the bottom (Pl. VII. Fig. 11), the edge is very finely serrate, the outer part sinuate; they join in their whole length. They have an arc below the basal part like the ophicephalous ones and can, indeed, hardly be distinguished from the larger ophicephalous pedicellariæ. The triphyllous pedicellariæ are like those of *A. formosus*. Spicules are scarce in the tubefeet, numerous in the buccal membrane and at the base of the spines.

This species, when preserved with the spines, can only be confounded with *A. formosus*, from which species, however, it seems very well distinguished, especially by its large ophicephalous pedicellariæ. The base of the spines is dark green in *A. ovum*, pink in *A. formosus*; but this is no constant feature, as they may



Fig. 9. Primary spine of *Amblypneustes formosus* (Obj. 0. Oc. 0).

be white in both species. From the other species, *A. griseus* and *pallidus*, it is at once distinguished by its slender primary spines, which are not swollen in the point.

The literary references to this species are very unreliable. The *Amblypneustes ovum* named by BELL in his „Notes on the Echinoderms collected at Port Philip by Mr. J. Br. Wilson“¹⁾ are not that species. The glass which has that name on the label contains: 3 specimens of *Microcyphus zigzag* (among which there is one large one, agreeing exactly with that figured in „Rev. of Ech.“. Pl. VIII. c. 11—12), 1 *Micr. elegans*, 1 *Micr. annulatus*, 1 *Holopneustes purpurascens*, 3 *H. inflatus* and 2 *H. porosissimus*, but no *Amblypneustes*. In Strassburg I have seen a specimen of *Holopneustes* (*purpurascens*?) determined by RAMSAY as *A. ovum*, which proves that RAMSAY has not known the true *A. ovum*, and his remarks²⁾ on the variation in colour and form of this species are thus valueless. — Of 10 naked tests lying in one box under the name of *A. ovum* in the British Museum I found 8 specimens to be *Holopneustes*, 2 only *Amblypneustes*. This shows that no reliance can be put on the remarks of BELL³⁾ on this species either. — The statement of the occurrence at Cape of Good Hope of *A. ovum* (BELL. Op. cit.) is based on two specimens (naked tests) from Dr. BOWERBANK, 1860. That the locality is wrong, can scarcely be doubted.

Amblypneustes pallidus (Lamk.). In the Museum of Copenhagen is preserved a beautiful specimen of an *Amblypneustes*, which is certainly the same species as that described in „Rev. of Ech.“ as *A. pallidus*. It is like *A. formosus* in the form of the test. The globiferous pedicellariæ are perhaps a little more slender than those of *formosus*, but otherwise they agree with them. The ophicephalous pedicellariæ (Pl. VII. Fig. 42) are somewhat more elongate. Tridentate pedicellariæ are found, though exceedingly scarce; they are small, c. 0.5 mm. (head). The valves (Pl. VI. Fig. 48) are simply leafshaped, without meshwork in the bottom; they join in their whole length. The edge is a little sinuate in the outer part, otherwise smooth. The triphyllous pedicellariæ (Pl. VII. Fig. 12) are a little widened in the outer part of the blade. The buccal membrane contains a ring of rather large, rounded plates in the oral edge, otherwise only bihamate spicules in rather great number. In the tubefeet these spicules are very scarce. The spines are rather slender, swollen at the point, without central thorn (Pl. II. Fig. 21). The primary spines are green, the secondary ones white, faintly tipped with violet.

The specimen here described cannot belong to any of the other species of *Amblypneustes*, since it differs from *griseus* in the high shape of the test, from *formosus* and *ovum* in its clubshaped spines. Thus I cannot agree with AGASSIZ, who is convinced that *A. pallidus* will prove identical with *formosus* (Rev. of Ech. p. 482),

¹⁾ Ann. Nat. Hist. 6. Ser. II. 1888. p. 402.

²⁾ Catalogue Ech. in the Australian Museum. I. Echini. 1891. p. 52.

³⁾ On some genera and species of the Temnopleuridae. Proc. Zool. Soc. 1880.

neither with T. Woods, who suggests that *A. griseus* and *pallidus* may be only varieties of *A. ovum*¹⁾. However, I am not sure that it is really *A. pallidus*. In „Voyage de la Frégate Venus.“ Atlas de Zoologie. Zoophytes. Pl. II. Fig. 1 is figured the test of an *A. pallidus*, which is rather low, like an *Echinus*, not egg-shaped as in the above mentioned specimen. Also a spine is figured; it is not clubshaped, but tapering. If this form be the true *A. pallidus*, the specimen described above must be a new species. I cannot settle this question for the present, and thus, of course, shall not add to the confusion of the *Amblypneustes*-species by giving a new name to this form. Till the contrary be proved I must regard it as *A. pallidus*.

Amblypneustes griseus (Blv.). This species is easily distinguished by the somewhat depressed test. The pedicellariæ are like those of *formosus*; the spines are clubshaped, both primary and secondary ones. In large specimens of this species there may be a little irregularity in the occurrence of the primary ambulacral tubercles; no confusion with *Holopneustes* should, however, take place, the regular trigeminate arcs of pores showing sufficient difference from the irregular arrangement of the pores in that genus. — The notes on this species given by BELL (On the genera and species of Temnopleuridæ. p. 436) are not reliable. Of the eleven specimens mentioned there I find 7 to be *Holopneustes*, 3 probably *A. ovum* and only one *A. griseus*. A similar result I found concerning *A. ovum* (comp. above, p. 104), and what is named *A. pallidus* in that paper is likewise not that species alone. Upon the whole it is scarcely possible for the present to distinguish these species by the naked tests alone; that it will prove a possible thing to do so with certainty, when once examinations have been made on sufficient fresh material, seems not improbable.

Amblypneustes grossularia Studer. (The type-specimen examined in the Berlin-Museum). The globiferous pedicellariæ are larger than those of the other species of this genus; also the form of the valves is somewhat different (Pl. VI. Fig. 33), but as usual there is one unpaired lateral tooth. The ophicephalous pedicellariæ (Pl. VII. Fig. 52) are narrowed in the middle, differing thus rather markedly from those of the other species. The triphyllous pedicellariæ (Pl. VI. Fig. 21) have the blade much widened, whereas in all the other species of *Amblypneustes* (and *Holopneustes*) the blade is narrow (comp. the figure given for *A. formosus*, Pl. VII. Fig. 13). Spicules as in the other species. The secondary spines are a little swollen at the point and without central thorn; how the primary spines end I cannot say, having seen only broken ones. — STUDER says in his description of this species²⁾: „die Spinen sind klein und spitz, ähnlich wie bei *Salenia*“; this must be a lapsus calami for *Salmacis*; they are not in the least similar to those of *Salenia*. The statement of STUDER that there are 4 pairs of pores to each compound ambulacral plate is wrong; there are really only three. — That this species is not the young

¹⁾ On the habits of some Australian Echini. Proc. Linn. Soc. N. S. Wales. V. 1881. p. 193.

²⁾ Übersicht über die während der Reise S. M. S. Gazelle ges. Echinoidea. Monatsber. Akad. Berlin. 1880. p. 873.

of some one of the other known species of *Amblypneustes*, as STUDER thinks possible (Op. cit. p. 874) is quite certain; it is, on the contrary, rather remote from all the other species, and perhaps ought not to be retained in that genus.

Amblypneustes vegæ Lovén (mentioned by DÖDERLEIN in his paper „Seeigel von Japan und den Liu-Kiu-Inseln, p. 38, but not published by LOVÉN himself) is only *Mespilia globulus*; Prof. THÉEL has kindly sent me a specimen from the Stockholm-Museum.

Holopneustes purpurascens Ltk.¹⁾ The type specimen is a naked test, but the spines and some pedicellariæ have been preserved. The spines (Fig. 10, Pl. II. Fig. 24) are distinctly clubshaped and red coloured. The ophicephalous pedicellariæ (Pl. VII. Fig. 32) have rather elongate valves, not narrowed in the middle. The triphyllous pedicellariæ are like those of *A. formosus* etc. Globiferous pedicellariæ I have not been able to find among the remnants preserved of the type-specimen; but in the specimen from Port Phillip mentioned above (p. 104) I find them to be like those of *A. formosus*. — In his description of this species in „Rev. of Ech.“ p. 485 AGASSIZ says: „actinal and abactinal diameter equal“. If that means diameter and height, the statement is correct (53—52 mm. in the type-specimen). Further AGASSIZ says: „poriferous zone equal in width to the corresponding tuberculiferous ambulacral space“ — this is wrong; the poriferous zone is not equal in width to the whole interporiferous area (as is the case in *H. porosissimus*), only a little more than half as wide as the whole interporiferous zone (comp. measurements given below). The outer row of pores is said to be „characterized by the greater size of the inner pore, and the distance separating the pores of a pair“. I do not find this feature distinct in the type specimen, nor in the other specimen examined. „In large specimens the middle row of pores is very irregular“ — in the type-specimen, which may well be said to be a large specimen, the median row is almost quite regular. „The tubercles of both areas form most regular horizontal rows“. This does not suit very well with the type-specimen. In the interambulacra there are at the ambitus inside the primary tubercle about 5 tubercles, much smaller than the primary one, forming a rather regular horizontal row in the middle of the plate; some few small secondary tubercles are more or less regularly disposed at the upper and lower edge of the plate. Outside the primary tubercle there are more secondary tubercles, among which one is larger than the rest, but not quite so large as the primary one; these larger tubercles form a rather regular vertical series besides that formed by the primary tubercles. In the ambulacra there is a row of three tubercles, almost equally sized, in a few plates; these rows, however, are not horizontal but markedly oblique, rising towards the median line of the area.



Fig. 10. Primary spine of *Holopneustes purpurascens*. (Obj. A*. Oc. 3.)

¹⁾ Not *purpureus*, as spelled in „Rev. of Ech.“

AGASSIZ thinks it possible that this species will prove to be „nothing but *H. porosissimus* with a rather narrow poriferous zone“. It is a priori very improbable that so large specimens as the type (53 mm.) should not yet have attained the definitive arrangement of the pores, and the fact that in specimens of *porosissimus* of much smaller size the characters in the ambulaera are already very distinct (comp. measurements below), definitely proves that it must be two distinct species.

Holopneustes inflatus Ltk. The type-specimen is a naked test, only some spines being preserved; they are clubshaped, of a faint reddish tint. In the British Museum I have found some small specimens of this species from Port Philip (named *Ambl. ovum*); they show that in pedicellariæ and spicules there is no difference from *H. purpurascens*. In the description of this species given by AGASSIZ (Rev. of Ech. p. 483) it is said: „poriferous zone more than equalling in width the median ambulacral region“; as in *H. purpurascens* this means not the whole interporiferous zone, but only half of it, the poriferous zone being only a little more than half as wide as the median, non-poriferous part of the ambulacral area. A feature worth mentioning for this species is this that the interambulacral plates make a distinct curve downwards below the primary tubercle, most distinctly on the abactinal side; in *H. purpurascens* this feature is very indistinct in the type-specimen, but in the small specimen from Port Philip it is rather distinct, as is also generally the case in *H. porosissimus*. It may also be noted that the ambulaera are only as wide as the interambulacra, whereas in *H. porosissimus* they are distinctly wider than the interambulacra even in quite small specimens. By this feature *H. inflatus* is easily distinguished from *porosissimus*, whereas it is difficult to distinguish it from *purpurascens*. The test is higher in *purpurascens* and the whole form is different; in *purpurascens* the test is eggshaped, narrowing evenly towards the mouth, whereas in *inflatus* the actinal side is rather broad and flat. Also the colour is different, dark purplish red in *purpurascens*, faint reddish or brownish in *inflatus* (both test and spines). Perhaps it will not be possible to maintain *inflatus* as a distinct species; there is in the Copenhagen Museum a large specimen from Victoria (42 mm.) which seems to hold an intermediate position between *purpurascens* and *inflatus*. But from the scanty material at my disposal I dare not say with certainty whether *inflatus* has to be made synonymous with *purpurascens* or maintained as a distinct species. The suggestion of RAMSAY¹⁾ respecting the three *Holopneustes*-species that „it is quite likely that they all belong to one species“ is undoubtedly wrong and caused by his having confounded not only the species but also the genera *Amblypneustes* and *Holopneustes* (see above, sub. *A. ovum*); in any case the two species *purpurascens* and *porosissimus* must be maintained.

Holopneustes porosissimus Agass. The pedicellariæ are like those of *H. purpurascens*; the spines are strongly clubshaped and of a conspicuous red colour. I have examined two young specimens from Port Philip; they agree with the larger spe-

¹⁾ Catalogue Ech. in the Australian Museum. 1. Echini. 1891. p. 52.

cimens in having the ambulacra distinctly wider than the interambulacra, so they must be referred to this species, according to our present knowledge. I should not, however, be very surprised, if there should prove to exist more than one species of *Holopneustes* with such wide ambulacra.

I give here some measurements of the specimens before me of the three *Holopneustes*-species. These give very good distinguishing characters, which are the more needed as no specific characters are found in pedicellariæ, spicules or structure of spines.

	Diameter.	Height.	Width of				
			Inter-ambulacra.	Ambulacra.	Poriferous zone.	Interporiferous zone.	
<i>Holopn. purpurascens</i>	53	52	16.5	16	4.5	7	(Type-specimen.)
— — (?)	42	38.5	14	12	3.5	6	(The measurements of interporiferous and poriferous zones together give 13 mm: the measurement 12 mm. for the whole ambulacral area is due partly to the rounding of the test, partly to inevitable small errors in the measuring.)
— —	16	13.5	4.5	4.5	1	3	
— <i>inflatus</i>	36	30	11.5	11	3	5	
— —	40	33	12.5	13	4	6	(Type-specimen.)
— —	40	32.5	12	12	3.5	6	
— —	22.5	17.5	7	7.5	2	3.8	
— —	17.5	13	5.5	5.8	1.5	3	
— —	16	12	4.8	5	1	2.5	
— —	11.5	9.5	3.2	3.2	0.8	2	
— <i>porosissimus</i>	70	58	18	24	8	8	
— —	36	30	10.2	13	4.2	4.6	
— —	35	27	10	13	4	5	
— —	17	12	4	5.5	1.5	2	
— —	11	8.5	3	4	1	1.8	

These researches on the *Amblypneustes*- and *Holopneustes*-species seem to show that they are not so difficult to distinguish as commonly believed, when only the specimens are preserved with their spines etc., whereas naked tests cannot always be distinguished with full certainty, at any rate in the present state of our knowledge. The analytical table of these species given below will, I hope, prove to be useful. (Due allowance, however, must be made for the uncertainty, whether the species named *A. pallidus*, is really that species; comp. above p. 105.) In this table I also include the species of *Microcyphus*, so much like *Amblypneustes* (except *M. maculatus*), and *Goniopneustes*. Upon the whole these species differ very little in appearance and will certainly be confounded without a close examination, as I have shown to have been the case in several instances.

LÜTKEN¹⁾ places the genera *Amblypneustes* and *Holopneustes* in a separate group, *Amblypneustidae*. They are certainly nearly related, but there is no reason to separate them from the family of the *Temnopleuridae*, whose most specialized members they are.

Analytical table of the species of *Microcyphus*, *Amblypneustes*,
Holopneustes and *Goniopneustes*.

1. A primary tubercle found on all the ambulacral plates; the pores arranged in regular arcs of three 2.
 A primary tubercle found only on every second or third ambulacral plate, or even more irregularly 9.
2. The median space of both areas bare and smooth (*Microcyphus*) 3.
 No distinct bare median space, the tubercles reaching to the median line of the areas (*Amblypneustes*) 6.
3. The test low; the median naked spaces very large. The spines rather stout, green. Globiferous pedicellariæ without lateral teeth ... *Microcyphus maculatus* Agass.
 The test high. Globiferous pedicellariæ with or without an unpaired lateral tooth; spines not green 4.
4. Spines red-banded; the test elongate (always?) *Microcyphus annulatus* Mrtsn.
 Spines not banded; the test eggshaped .. 5.
5. The naked spaces narrow, dark brown coloured, standing very prominently against the faint red colour of the other part of the test. Spines intensely red *Microcyphus zigzag* Agass.
 The whole test of a uniform beautiful red colour; spines faintly reddish *Microcyphus elegans* Mrtsn.
6. Test high, eggshaped 7.
 Test somewhat depressed, sphaeroidal; spines clubshaped *Amblypneustes griseus* (Blv.).
7. Primary spines clubshaped, green, faint lozenge-shaped figures on the test. Ophicephalous pedicellariæ not very elongate *Amblypneustes pallidus* (Lmk.).
 Primary spines not clubshaped 8.

¹⁾ Bidrag til Kundskab om Echiniderne. p. 84.

8. Spines red at the base; ophicephalous pedicellariæ not elongate; distinct lozenge-shaped figures on the test *Amblypneustes formosus* Val.
 Spines dark green at the base; ophicephalous pedicellariæ partly very elongate. No lozenge-shaped figures on the test *Amblypneustes ovum* (Lmk.).
9. Two ocular plates reaching the periproct; primary spines very prominent, not clubshaped *Goniopneustes pentagonus* (A. Ag.).
 No ocular plates reaching the periproct; primary spines not prominent, clubshaped. (Holopneustes.) 10.
10. Ambulacra distinctly wider than interambulacra *Holopneustes porosissimus* Agass.
 Ambulacra not distinctly wider than interambulacra 11.
11. Test high, eggshaped, narrowed towards the mouth; spines and test dark red *Holopneustes purpurascens* Ltk.
 Test rather low, sphæroidal; the actinal side somewhat flattened; spines and test faint reddish *Holopneustes inflatus* Ltk.

The genera united by AGASSIZ in „Rev. of Ech.“ under the name *Tenuopleuridæ* have been universally acknowledged as forming a natural group. Only LAMBERT¹⁾ has a different view of their relations; he places the „*Satmacinæ*“ under the *Phymosominæ*, and the „*Temnechinæ*“ and „*Pleurechinæ*“ under the *Echininæ*; the *Phymosominæ*, *Arbaciadinæ* and *Echininæ* being again placed as subfamilies of the family *Echiuometridæ*. This classification gains no support at all from the researches on the regular Echinids, represented here and in the „Ingolf“-Echinoidea, nor from those of any other recent author on that subject, and LAMBERT does not give more detailed reasons for assuming this classification; it can then be dropped, I think, without further discussion. DUNCAN has shown, through his excellent researches on the structure of the test of the *Tenuopleuridæ*²⁾ that the genera form two separate groups, the one having true pits undermining the test and the plates being united by knobs and sockets, the other having only sutural depressions or a raised ornamentation on the plates, the plates not being united by knobs and sockets. In his „Revision“ these groups are made subfamilies of the fam. *Tenuopleuridæ*, the one, *Temnopleuriæ*, including the genera *Temnopleurus*, *Pleurechinus* (regarded as a subgenus only of the former), *Temnechinus*

¹⁾ Étude sur quelques Échinides de l'Infra Lias et du Lias. Bull. Soc. Sc. de l'Yonne. 1899.

²⁾ On some Points in the Morphology of the test of the *Temnopleuridæ*. On the genus *Pleurechinus*. (J. Linn. Soc. XVI. 1881.)

(including *Opechinus* and *Genocidaris*), *Salmacis* (with *Salmacopsis* as a subgenus), *Mespilia*, *Microcyphus*, *Amblypneustes*, *Goniopneustes* and *Holopneustes*, the other, *Glyphocyphinae*, including *Trigonocidaris* and the fossil genera: *Glyphocyphus*, *Dictyopleurus*, *Arachniopleurus*, *Ortholophus*, *Paradoxechinus*, *Echinocyphus*, *Zeuglopleurus*, *Lepidopleurus*, *Leiocyphus* and *Coptophyma*. In his „Revision of the British fossil Cænozoic Echinoidea“¹⁾ GREGORY suggests that *Temnechinus*, as having no true pits, ought to be transferred to the *Glyphocyphinae*. In the „Treatise on Zoology“, however, he retains this genus among the *Temnopleurinae*; further the subfam. *Glyphocyphinae* is restricted so as to comprise those genera „in which the compound ambulacral plates are composed of three primaries“, the genera „in which the compound ambulacral plates are composed of two primaries and an intermediate demi-plate“ being made another subfamily, *Ortholophinae*; to the latter subfamily *Trigonocidaris* is also referred, though with a mark of interrogation (Op. cit. p. 312).

According to AGASSIZ („Blake“-Echini. p. 38) „the presence of pits and sutures is a feature only developed with age, and the transition is insensible between the types in which the pits and sutures are formed by the modification of a flat surface due on one side to the thickening or elevation of nearly the whole plate, or, on the other, of only a portion of it“. I cannot agree with AGASSIZ herein; I find the pits very distinct in very small specimens, as small as, upon the whole, it is possible to determine with certainty. — The distinction between true and false pits is thus certainly of great importance, and I quite agree with DUNCAN and GREGORY that the genera of the *Temnopleuridae* must be classified upon this structure. The forms with true pits have also the plates united by „dowelling“, and they further agree in having, generally, smooth plates without superficial ornamentation (in this respect, however, *Pleurechinus scillæ* is a very conspicuous exception). These genera: *Tenuopleurus*, *Pleurechinus*, *Salmacis*, *Salmacopsis*, *Mespilia*, *Microcyphus*, *Amblypneustes*, *Goniopneustes* and *Holopneustes* evidently form a natural group and must form a subfamily *Temnopleurinae*. The other genera: *Hypsiechinus*, *Prionechinus*²⁾, *Genocidaris*, *Trigonocidaris*, *Temuechinus* and *Opechinus* differ from the *Temnopleurinae* in having no true pits and the plates not united by dowelling. DUNCAN evidently contradicts his own results when saying in his diagnosis of the whole family *Temnopleuridae* that the plates are united by dowelling. In his paper „On the genus *Pleurechinus*“ (p. 454) he emphasizes that in *Temnechinus* „none of the remarkable minute structures of the test of *Temnopleurus* are present“ (which, I can state, is correct, after examining an excellently preserved fragment of *Tenuuechinus Woodi* (Agass.) in the British Museum), and in another paper „On some Points in the Anatomy of the *Temnopleuridae*“³⁾ he says with regard to the recent

¹⁾ Proc. Geologists Assoc. XII. 1891. p. 30.

²⁾ *Arbacina (Cottaldia) forbesiana* has been shown by DE MEJERE to be a *Prionechinus* („Siboga“-Ech. p. 71).

³⁾ Ann. Nat. Hist. 6. Ser. I. 1888. p. 110.

„*Temnechinus*“ (*Genocidaris*) *maculatus*: „should the knob-and-socket arrangement of the union of the plates be discovered, *Temnechinus* will enter the *Temnopleurinae*“. This contradiction by DUNCAN unfortunately has been more accentuated by GREGORY, who expressly says in the diagnosis of the *Glyphocyphinae* and *Ortholophinae* „the plates are united by dowelling“, whereas this sentence is omitted in the diagnosis of the *Temnopleurinae*. The fact is just the opposite, as originally shown by DUNGAN. To be sure all the genera without true pits have not been examined with respect to this structure, but it may be justifiable to conclude from those examined that in none of these genera such a dowelling exists. Of *Temnechinus* the fact is stated above; *Trigonocidaris albida* and *Genocidaris maculata* have been examined by AGASSIZ („Blake“-Echini. p. 37) with the result that no dowelling exists, and the same I can state for *Hypsiechinus*.

The genera *Hypsiechinus*, *Prionechinus*, *Genocidaris*, *Trigonocidaris*, *Temnechinus* and *Opechinus* must then form a second subfamily: *Temnechininae*. (In DELAGE & HÉROUARD's „Traité de Zoologie concrète“ for which work I have written the classification of the regular Echinoidea, this subfamily is named *Trigonocidarinae*. It will be more convenient to name it *Temnechininae*, the more so, as this name has already been used by LAMBERT (comp. above p. 110), though perhaps not exactly in the sense in which it is used here). — The genera *Hypsiechinus* and *Prionechinus*, to be sure, differ considerably from the other genera, the former by its triradiate spicules and its globiferous pedicellariæ (comp. „Ingolf“-Echinoidea. p. 86), the latter by its smooth test. It would, in fact, be very difficult to say by which characters *Prionechinus* is distinguished from the Echinometrids. There can, however, be scarcely any doubt that they are both most nearly related to *Trigonocidaris* and *Genocidaris*. — The name *Glyphocyphinae* cannot be used for this subfamily. The genus *Glyphocyphus* Haime has perforate and crenulate tubercles, and the same holds good for the genera *Dictyopleurus* Dunc. & Sladen and *Arachniopleurus* Dunc. & Sladen; these genera thus cannot belong to the *Temnopleuridae*, but, probably, form a special group of the Diadematids, distinguished by the ornamentation of the test. The name *Glyphocyphinae* may be retained for this group. The ambulacral structure of *Arachniopleurus* is not sufficiently known, but from the perforate tubercles it may be concluded that it will prove to be diadematoid; in *Glyphocyphus* the ambulacral plates are composed of low, broad primaries, with straight transverse sutures, and in *Dictyopleurus* they are of true diadematoid structure. The genus *Ortholophus* Dunc. seems really to be related to *Trigonocidaris*, but I should prefer not to name the subfamily after a little known fossil form, whose relation to the recent genera is not beyond doubt. The name „*Ortholophinae*“ then ought not to be used. — Among the other fossil genera referred by DUNCAN to the Temnopleurids *Zenglopterus* Greg. has diadematoid ambulacra, and the same may be the case with *Echinocyphus* Cott. and *Leiocyphus* Cott., which thus cannot remain here, whereas

Paradoxechinus Laube, *Coptophyma* Per. & Gauth. and *Lepidopleurus* Dunc. & Sladen may really belong to this subfamily.

The natural arrangement of the genera of Temnopleurids then seems to be as follows:

Fam. *Temnopleuridæ*.

Subfam. *Temnechininæ*. No pits; mostly raised ornamentation on the plates or low sutural depressions. Plates not united by dowelling:

Genera: *Hypsiechinus* Mrtsn., *Prionechinus* A. Ag., *Genocidaris* A. Ag., *Trigonocidaris* A. Ag., *Temnechinus* Forb., *Opechinus* Desor, *Ortholophus* Dunc., *Paradoxechinus* Laube, *Coptophyma* Per. & Gauth., *Lepidopleurus* Dunc. & Sladen.

Subfam. *Temnopleurinæ*. True pits; the plates united by dowelling, mostly with smooth surface.

Genera: *Temnopleurus* Agass., *Pleurechinus* Agass., *Salmacis* Agass., *Salmacopsis* Döderl., *Mespitia* Agass., *Microcyphus* Agass., *Amblypneustes* Agass., *Goniopneustes* Dunc., *Holopneustes* Agass.

Fam. *Toxopneustidæ*.

Subfam. *Schizechininæ*.

14. *Gymnechinus pulchellus* n.sp.

Pl. I. Figs. 16, 23. Pl. II. Fig. 11. Pl. VII. Figs. 8, 29, 36, 41, 46.

The test is very low, both sides flat, or (in the larger specimens) the abactinal side gently rising towards the apical system; it is a little pentagonal, the ambulacra raising somewhat above the interambulacra at the ambitus. The mouth edge is a little inwardly curved. A few measurements may be given here.

Diameter.	Height.	Peristome.	Apical system.	Width of		Number of plates.		Longest spines.
				Ambulacra	I.-ambulacra.	Ambulacra.	I.-ambulacra.	
19 ¹⁾ mm.	9 mm.	7 mm.	6 mm.	4.5	7	17—18	13	4
15 —	7 —	6 —	4.5 —	4	5	14—15	12	—1
11 —	5 —	5 —	3.8 —	3	4	13—14	11	3

¹⁾ The largest specimen.

Ambulacra rather broad, though distinctly narrower than the interambulacra; also at the peristome they are distinctly narrower than the latter. The pores

are disposed in rather inclined arcs, the outer pair being placed close to the edge of the area. At the peristome the pores are smaller, the pore-area narrower than at and above the ambitus. The plates are rather high, not much exceeding the interambulacral plates in number. The sutures are rather indistinct, somewhat inclining outwards. The primary tubercles (one to each ambulacral plate as in the other species of this genus) form a very distinct and regular vertical series, diminishing a little in size towards the apical system and very little so towards the peristome. Inside the primary tubercle there is a smaller secondary one at the upper edge of the plate, forming likewise a more or less regular vertical series; in larger specimens a secondary tubercle may be found also at the inner edge of the plates at the ambitus. Between the primary tubercle and the pores there is a small tubercle on each plate, forming likewise a regular vertical series.

The interambulacral plates have a primary tubercle situated about in the middle of the plate, not much larger than the ambulacral ones; they form a beautiful vertical series, not distinctly diminishing in size towards the mouth or apex. Inside the primary tubercle there is, as in the ambulacra, a secondary tubercle at the upper edge of the plate and one at the inner edge; the latter is mostly the larger and may form a rather prominent vertical series. A few more small tubercles may be found, irregularly placed. Outside the primary tubercle some secondary tubercles are found, partly disposed, in larger specimens, in two more or less distinct vertical series, and forming also together with the primary tubercle and the median inner tubercle a more or less distinct horizontal row of four tubercles. Miliary tubercles very few and indistinct.

The apical area is like that of *G. Robillardi* (de Lorient) (Pl. II Fig. 11). The periproct is pushed out towards the right posterior Interradius, the corresponding genital plate being quite low. The genital plates of the opposite side are on the contrary very high and large; sometimes one or two of them are divided by a transverse line into an inner and outer part, and sometimes one of the genital plates, mostly the left anterior, may be excluded from the periproct. The genital openings are formed already in specimens of 5 mm. diameter. The two ocular plates are broadly in contact with the periproct, the others widely separated therefrom. A single rather large tubercle is found in the middle of each genital and ocular plate, except the posterior, low genital plate. The periproct is covered by several small, irregular, smooth plates, among which no distinct central plate can be made out (in larger specimens). The anal opening is situated nearest to the posterior edge of the periproct.

The buccal membrane is naked; in the oral edge a single irregular rod may be found, but mostly there is none. Outside the buccal plates some very few small fenestrated plates may occur in larger specimens. Bihamate spicules are almost quite wanting in the buccal membrane; in the gills there are mostly a few; here and there, however, larger numbers are found, but the usual irregular, fenestrated plates are not

met with. The buccal plates are placed one a little outside the other. A few pedicellariæ are found on the buccal plates in larger specimens. The mouthslits are small but rather sharp.

The spines are smooth, short, those at the ambitus and just below being the longest (about $\frac{1}{4}$ of the diameter of the test); towards the apical system they become gradually shorter. Those round the actinostome are a little curved, not widened at the point; they are beautifully red coloured and tipped with white.

The globiferous pedicellariæ (Pl. VII. Fig. 8) do not present marked characters by which they may be distinguished from those of the other *Gymnechinus*-species. There are glands on the stalk. „Claviform“ pedicellariæ are also found. The tridentate pedicellariæ (Pl. VII. Fig. 29) are very characteristic. The blade is narrow in the lower part, with a more or less developed meshwork high up from the bottom uniting the sides; the outer part is widened, the edges irregularly sinuate and finely serrate; the edge of the lower part is smooth or with a few irregularly placed serrations. The valves join only with the outer, widened part. Length of the head c. 0.5 mm. The ophicephalous pedicellariæ (Pl. VII. Fig. 41) do not present peculiar features; the triphyllous ones (Pl. VII. Fig. 36) have the blade rather widened, otherwise they are of the common form. — The sphaeridia are smooth, of the usual form. — The spicules of the globiferous pedicellariæ (Pl. VII. Fig. 46) are bowshaped, with the ends thickened. In the tubefeet a few bihamate spicules are found. The walls of the intestine may contain some very few small bihamate spicules; in the genital organs I have seen none.

The auricles are formed of two high, narrow processes, which do not unite above, even in the largest specimens. The dental apparatus is low and strongly rounded below.

The colour of the test is white, with a faint reddish tint, the red colour of the spines looking most delicate against the white ground colour.

A considerable number of this beautiful little species was taken at several localities in the Gulf of Siam: Koh Kam, 5–10 fathoms, Koh Kram, 30 faths., Koh Mesan, 5–15 faths., Koh Kahdat, 1–10 faths., Koh Mak, 5–6 faths., all on hard bottom, sand, gravel or stone. Further a few specimens have been taken at Singapore by Mr. GAD, 1903. A great number of them carried an empty bivalve shell on them, held rather firmly by the abactinal suckers, the whole animal being thereby quite covered, when seen from above. From the Maldive Islands I have seen 3 small specimens (in the collection sent me for examination from Prof. S. F. Harmer), which appear to belong to this species, but as tridentate pedicellariæ could not be found, I dare not affirm that they belong to this species. The colour of the spines is faint violet. (They were named *Temno-pleurus*?)

In the „Ingolf“-Echinoidea (p. 110) I have written of *Gymnech. darnleyensis* that the ocular plates are not excluded from the periproct, according to infor-

mation received from Prof. BELL in a letter to me. Trusting to this statement DE MEIJERE has concluded that *G. darnleyensis* has the apical system „sehr schief ausgebildet“, and on this account he has referred some specimens from the „Siboga“-Expedition to that species. Now I must state, after having reexamined the specimens of *G. darnleyensis* in the British Museum during my visit there last summer, that all the ocular plates are, indeed, excluded from the periproct, the apical system being regular and very different from the oblique apical system in *G. Robillardi* and *pulchellus*. Seeing thus that the „Siboga“-specimens could not belong to *darnleyensis*, I asked Dr. DE MEIJERE to send me some specimens for examination. He most kindly sent me two specimens; they prove to be nearly related to *G. pulchellus*. They are somewhat larger than the largest Siamese specimens (23 mm. diam., 11 mm. height and 18.5 mm. diam., 10.5 mm. height) and the form of the test is somewhat different being higher at the ambitus and more flat on the abactinal side than in the larger specimens of *pulchellus*; the smaller specimen agrees with the Siamese specimens in colour, the spines only being of a more violet tint: the larger specimen has the abactinal spines faintly greenish, indistinctly banded, the actinal ones are a little violet, and there is a faint greenish tint on the test towards the apical system. The tridentate pedicellariæ do not quite agree with those of the Siamese specimens. In the smaller specimen the lower part of the blade is not so narrow, and the holes in the outer part are conspicuously lengthened; in the larger specimen they are, again, of another form, more leafshaped, broadest in the middle, and the edge of the lower part strongly serrate; the holes are small and round. It thus seems doubtful, whether they can be referred to *G. pulchellus*; they even seem to be two different species. But a larger material is needed for establishing the constancy of these features before the specimens can be made separate species.

Some specimens from Macclesfield Bank, mentioned by BELL¹⁾ as *Temno-pleurns Reynaudi* (and some more specimens from the same locality found in the British Museum, only named „*Echinus*“) prove to be a new species of *Gymnechinus*, allied to *G. pulchellus*, which I may describe here as *Gymnechinus versicolor* n. sp.

The test is very low, faintly conical on the abactinal side, with the mouth-edge rather strongly incurved. The tuberculation is rather rich. In both areas there is a larger secondary tubercle in the inner edge of the plate, forming a somewhat irregular longitudinal series. In the interambulacra the secondary tubercles form a rather distinct

Diameter.	Height.	Peri- stome.	Width of		Number of plates.		Longest spines.
			Ambulacra.	I.-ambulacra.	Ambulacra.	I.-ambulacra.	
26 mm.	12	8	6	9.5	c. 22	17	8

¹⁾ Echinoderms of Macclesfield Bank. p. 410.

circle around the primary one. Between each two adjoining primary interambulacral tubercles there is (on the abactinal side) a narrow, slightly elevated ridge with a small tubercle on the middle, connecting the primary tubercles. In the ambulacra such a ridge may be faintly indicated. The median space, in both areas, is bare and a little sunken: it is rather large in the interambulacra. The apical system is like that of *G. pulchellus*. The spines are slender, those at the ambitus the longest, c. $\frac{1}{3}$ of the diameter of the test; the primary ones smooth, the secondary thorny; the actinal spines are not widened or curved. The auricles are low processes, which do not meet above to form an arc. The mouthslits are small but sharp. The buccal membrane has no plates in the mouth edge, but rather numerous small bihamate spicules (Pl. VII. Fig. 24. a) are found spread in the whole membrane; in the gills such spicules occur in great numbers together with the usual irregular plates. The tubefeet contain rather numerous small, very little curved, bihamate spicules (Pl. VII. Fig. 24 c.). The globiferous pedicellariæ present the shape usual in this genus; they have small glands on the stalk. Numerous small bowshaped spicules (Pl. VII. Fig. 24 d.) are found in them. The tridentate pedicellariæ are very characteristic (Pl. VII. Fig. 30); the blade is almost flat, narrow, widened in the outer part; the edge is smooth and in the outer part exceedingly finely serrate. The valves are a little curved and join only with the outer part. The neck is rather short. The ophicephalous pedicellariæ do not present any special characters; the triphyllous ones (Pl. VII. Fig. 26) differ somewhat in shape from those of *G. pulchellus*, the blade being less widened. The stalk and neck of these pedicellariæ contain numerous very small bihamate spicules (Pl. VII. Fig. 24. b.). — The colour of the test is wholly white, or with a faint brownish tint on the bare spaces. The spines are banded with 1–3 bands of red: in the lower part they are green or white, both types of colorations occurring in the same specimen. The base of the spines is red.

This beautiful species belongs to the group of *G. Robillardi*, distinguished by its remarkable oblique apical area; to the same group the species *G. pumilio* de Meijere¹⁾ seemed to belong. Through the kindness of Dr. DE MEIJERE, however, I have had a specimen for examination, and I must state that it is no *Gymnechinus*, but a *Psammechinus*, and that it is the species described by BELL (Echinoderms of Macclesfield Bank) as „*Salmacis*“ *rufa* (see below p. 122).

Gymnechinus darnleyensis (Woods) differs very markedly from all the species mentioned above in having a regular apical system with no ocular plates reaching the periproct (comp. above p. 116). In the „Ingolf“-Echinoidea (p. 110) I have stated that the auriculæ are of the usual form (according to a communication from Prof. BELL in a letter to me), as opposed to the statement of Woods²⁾ that they are slight thin processes, which do not meet. Having reexamined the specimens in the British Museum

¹⁾ „Siboga“-Echinoidea. p. 90

²⁾ The Echini of Australia Proc. Linn. Soc. N. S. Wales. II. 1878. p. 165.

I find them to be, as BELL states, connected above. (Also in a specimen received from Prof. DÖDERLEIN the auriculæ unite.) As these specimens otherwise agree well with the description, the statement of Woods probably may be due to his having confounded more than one species in his „*Echinus*“ *darnleyensis*. He describes the spines as being „rose pink, dull green or reddish, and sometimes banded or tipped with yellow“. Such a wide range of colours in a single species appears to me rather improbable. My experiences tend to show that colours in Echinids are generally much more constant than is commonly supposed, and I find colour in many cases a very good additional specific character. Thus all my numerous specimens of *G. pulchellus*, without exception, show a similar coloration, and the same is the case with the different *Saluacis*-species, *Pleurechinus* etc.

In the Museum of Copenhagen are preserved two specimens of a small Echinid from Funafuti, which agree in several respects with *G. darnleyensis*, but differ in other characters so much from that species that they must certainly form a distinct species, which I may describe here as *Gymnechinus inconspicuus* n.sp.

The form of the test is beautifully rounded, the height being more than half as large as the diameter of the test (6 mm. to a diameter of 10 mm.); it is regularly arched on the abactinal side. The primary tubercles of both areas form a regular vertical series, the ambulacral almost as large as the interambulacral ones. The ambulacral plates carry a secondary tubercle at the upper edge of the plate inside the primary one, at the ambitus there may also be a tubercle at the median edge. On the interambulacral plates there are two secondary tubercles at the upper edge, one to each side of the primary tubercle, further one inside and two outside the primary tubercle, all these secondary tubercles together forming an almost regular circle round the primary one. The apical system is like that of *darnleyensis*, with the periproct in the normal position and the anal opening central and surrounded by a circle of rather large plates. In the larger specimen (10 mm.) one ocular plate reaches the periproct, in the smaller one (8 mm.) they are all excluded. There is a rather large tubercle on all the ocular plates, none on the genital plates. The latter have a little area in the middle composed of more open, reticular tissue, looking like the madreporic plate, whereby the curious aspect is produced, as if all the genital plates were madreporic plates. The mouthslits are very small and indistinct; the auriculæ unite in the larger specimen, and one pair of them does so in the smaller specimen. The buccal membrane is quite bare, with only a few bihamate spicules; the buccal plates, which are placed at the same distance from the mouth-edge, carry some pedicellariæ. The gills contain numerous bihamate spicules, but no, or — in the small specimen — only a few fenestrated plates. The globiferous pedicellariæ have no glands on the stalk; the glands of the valves are small: no spicules found. The valves are like those of *darnleyensis*. The tridentate pedicellariæ are very different from those of *darnleyensis* (Pl. VI.

Fig. 45, Pl. VII. Fig. 39); the blade is very narrow, compressed in the lower part, widened in the outer part; the edge is irregularly sinuate, in the widened outer part finely serrate. The ophicephalous pedicellariæ are rather elongate, narrow, like those of *Psammechinus rufus* (Pl. VII. Fig. 43); the triphyllous ones widened in the outer part (Pl. VII. Fig. 54) and differing in form from those of *darnleyensis* (which are like those figured of *G. pulchellus*). No spicules have been found in pedicellariæ or tubefeet. The spines are short, about $\frac{1}{3}$ of the diameter of test, almost equally long over the whole test; the primary ones are smooth, the secondary faintly thorny, as is the case in all the *Gymnechinus*-species, and a little swollen at the point¹⁾; the actinal spines are not curved. — The colour of the test is brownish, with a darker median band in each area, in which the sutures may appear as white lines. The spines are of a bluish or reddish tint, lighter towards the point; in the smaller specimen those on the actinal side are indistinctly banded. — In both specimens the genital openings are distinct.

The 5 species of *Gymnechinus* thus far known form two distinct groups: the *Robillardi*-group, with excentric anal area, and the *darnleyensis*-group, with the anal area central. Perhaps these two groups ought to be made two subgenera; this, however, is of very little importance. To facilitate the determination of the species of *Gymnechinus*, which, together with *Psammechinus*, will doubtless prove to contain yet several species, I give here an analytical table of the species.

Table of the *Gymnechinus*-species.

- | | |
|--|------------------------------------|
| 1. Anal area central | 2. |
| — — excentric | 3. |
| 2. Elongate calcareous bodies in the inner edge of the buccal membrane; numerous dumbbell-shaped spicules in the globiferous pedicellariæ. Valves of tridentate pedicellariæ wide, not compressed in the lower part of the blade. Spines not swollen at the point..... | <i>G. darnleyensis</i> (Woods). |
| No elongate bodies in the inner edge of the buccal membrane; no spicules in the pedicellariæ. Tridentate pedicellariæ compressed in the lower part of the blade. Spines a little swollen at the point..... | <i>G. inconspicuus</i> Mrtsn. |
| 3. Spines white..... | <i>G. Robillardi</i> (de Lorient). |
| — red, white tipped, not banded..... | <i>G. pulchellus</i> Mrtsn. |
| — banded with red, the lower part mostly green.. | <i>G. versicolor</i> Mrtsn. |

¹⁾ In *darnleyensis* they are more evenly rounded or tapering.

15. *Toxopneustes pileolus* (Lamk.).

Echinus pileolus. LAMARCK. 1816. Animaux sans vertèbres. III. p. 45.

Boletia pileolus. AGASSIZ. & DESOR. 1846. Catalogue raisonné des Échinides. p. 362.

Toxopneustes pileolus. AGASSIZ. 1872. Revision of Echini. p. 167, 497. Pl. VIII. b. 1—2, XXV. 20, 21, XXXVIII. 16—17.

Boletia pileolus. DE LORIO. 1883. Catalogue rais. Échinod. île Maurice. p. 27.

Toxopneustes pileolus. DÖDERLEIN. 1885. Seeigel v. Japan u. d. Liu-Kiu-Inseln. p. 26.

— — WALTER. 1885. Ceylons Echinodermen. Jen. Zeitschr. f. Naturw. XVIII. p. 375

— — KOEHLER. 1895. Catalogue rais. Échinod. îles de la Sonde. p. 414.

— — MORTENSEN. 1903. Ingolf-Echinoidea. I. p. 111. Pl. XXI. 13, 21, 41.

— — DE MEIJERE. 1904. Siboga-Echinoidea. p. 92. Taf. XVII. 280 85.

Non: *Boletia rosea* A. Ag. (Comp. Ingolf-Echinoidea. I. p. 111).

— : — *bizonata* Desor.

— : *Echinus trizonalis* Blv.

Five specimens were taken at Koh Mesan, 10—15 fathoms, on hard bottom. On one of them a beautiful Ophiurid was found on the actinal side; also the small crab, mentioned under *Salmacis bicolor*, was found on this species, denuding also here the part of the test, where it had taken its place.

The well known transverse bands are rather differently developed, in one specimen almost quite wanting, in another very distinct; but the white zones are very narrow, the test looking thus rather different from the Polynesian specimens, where the white and violet or green bands are generally equally large. According to DE LORIO the specimens from Mauritius have no transverse bands; I must, however, remark that in a specimen from Mauritius in the Copenhagen-Museum the white transverse bands are found, though very narrow. Possibly the Indian specimens may be distinguished from the Polynesian ones as a distinct variety; but so far as I can judge from the material at my disposal no other differences can be pointed out than the colour of the test. In the pedicellariæ no difference is found.

In the „Ingolf“-Echinoidea (loc. cit.) I have said that no spines are found on the buccal plates in *T. pileolus*. This is not quite correct; there may be found a few small spines thereon, which holds good also for *T. roseus*. — The genital glands are of a curious reticulate structure; they are long and narrow, passing along the median line of the Interambulacra down to the actinal side. Some bihamate spicules are found in their walls; the walls of the intestine contain almost no spicules (bihamate).

Echinus trizonalis Blv. and *Boletia bizonata* Desor are stated by AGASSIZ and later authors to be synonymous with *T. pileolus*; as I have examined the type-specimens of these „species“ in Paris, I can positively affirm that this is not the case. To be sure, the type-specimens are only naked tests, but the fact that they have a primary tubercle on all ambulacral plates sufficiently shows that they cannot be the young of *T. pileolus*. There can scarcely be any doubt that they are either *Psamm-*

echinus variegatus or *Ps. verruculatus*; to which of these two species they belong can scarcely be decided, especially as the locality, from where they have come, is unknown.

Subfam. Parasaleninæ.

16. *Parasalenia gratiosa* A. Ag.

Pl. V. Fig. 36.

Parasalenia gratiosa. A. AGASSIZ. 1863. List of Echinoderms etc. Bull. Mus. Comp. Zool. 1. p. 22.

Echinomelra Arbacia. LÜTKEN. 1864. Bidrag til Kundskab om Echiniderne. p. 92 (160).

Parasalenia gratiosa. AGASSIZ. 1872. Revision of Echini. p. 148, 435.

— — STEWART. 1880. On some structural features of *Echinostrephus molaris*, *Parasalenia gratiosa* and *Stomopneustes variolaris*. Journ. R. Microsc. Soc. III. p. 909. Pl. XX.

— — PFEEFER. 1887. Über *Parasalenia gratiosa* (A. Ag.) u. *P. PöhlII* n. sp. Verhandl. d. Vereins f. naturw. Unterhaltung. Hamburg. VI. p. 107.

— *PöhlII*. PFEEFER. Ibidem.

— *gratiosa*. MEISSNER. 1892. Über *Parasalenia gratiosa* von Madagascar. Sitz. ber. Ges. naturf. Fr. Berlin. 1892.

— — SLUITER. 1895. Die Echiniden Sammlung des Museums z. Amsterdam. p. 69.

— — MORTENSEN. 1903. „Ingolf“-Echinoidea. I. p. 127. Pl. XXI. Fig. 32.

— — DE MEIJERE. 1904. „Siboga“-Echinoidea. p. 97. Taf. XVII. Fig. 290.

Non: *Parasalenia gratiosa*. BELL. 1903. Report on a Collection of Echinoderms from the Neighbourhood of Zanzibar. I. Ann. Nat. Hist. 7. Ser. XII. p. 247. (*Stomopneustes variolaris*.)

A few additional remarks may be given on this otherwise well known species. — The globiferous pedicellariæ contain numerous bihamate spicules; the skin on the upper end of the stalk is swollen, forming a gradual passage from the thin lower part to the head. This swelling might seem to be due to mucous glands, but according to DE MEIJERE there are no glands on the stalk. (The valves have been figured by STEWART.) It is a curious fact that the globiferous pedicellariæ are often totally wanting. In none of my specimens have I found them. The tridentate pedicellariæ (Pl. V. Fig. 36) are very slender and elongate, the head attaining sometimes even a length of more than 2 mm.; the valves join in the outer half of their length. Also quite small tridentate pedicellariæ are found, with simply leafshaped blades. The sphaeridiæ are of usual form and smooth. — No spicules are found in the walls of the intestine or genital organs.

4 specimens of this beautiful little Echinid were taken in old Coral blocks in about 1 fathoms depth at Koh Chang and the little Island Koh Sarlak in the Sound between Koh Chang and the mainland.

DE MEIJERE has shown that *Parasalenia PöhlII* cannot be distinguished from *P. gratiosa* by the characters pointed out as distinctive in the original diagnosis by

PFEFFER. I quite agree with DE MEIJERE herein and can add that neither in the pedicellariæ is any distinguishing character to be found. *P. Pöhlü* must then be withdrawn as a synonym of *P. gratiosa*.

AGASSIZ finds young specimens so unlike the larger ones that „they would at first glance readily pass for young of *Heterocentrotus trigonarius*“. I must confirm DE MEIJERE's statement that this is not the case; my smallest specimen (9 mm.) is so exactly like the larger specimens that I am quite unable to understand how even smaller specimens (AGASSIZ names 6 mm.) could look so different. AGASSIZ must probably have mistaken some young *Heterocentrotus* for *Parasalenia*.

This species evidently occurs in the whole Indo-Pacific region. As yet it was only known from Zanzibar and Madagascar in the Indian Ocean; I can add, besides the Gulf of Siam, the Red Sea, having seen a specimen therefrom in the British Museum. On the other hand having examined the specimen in the British Museum I must state that the *P. gratiosa* from Zanzibar, named by BELL (Op. cit.), is a lapsus for *Stomopneustes variolaris*.

I may here add a few remarks on *Psammechinus rufus*, *verruculatus* and *Echinometra oblonga*.

Psammechinus rufus (Bell). This species was described by BELL in his paper „On the Echinoderms of Macclesfield Bank“. p. 411 as *Salmacis rufa*. I have examined the type-specimens in the British Museum and find the species to be no *Salmacis* at all, but a Toxopneustid of the genus *Psammechinus*. Further I must state that the *Gymnechinus pumilio* described by DE MEIJERE („Siboga“-Echinoidea. p. 90) is the same species, DE MEIJERE having kindly lent me his largest specimen for examination. Perhaps the smaller specimens from the „Siboga“ are another species, as DE MEIJERE states that two ocular plates reach the periproct. In the larger specimen the apical system is like that figured by BELL, no ocular plate reaching the periproct and all the genital plates being low, thus differing very much from the genital plates in the *Gymnechinus*-species with excentric periproct. — To the descriptions given by the two authors I may add a few remarks. — The buccal membrane contains a great number of small irregular plates (Pl. V. Fig. 16), both inside and outside the buccal plates, which, as pointed out by DE MEIJERE, are placed very far from the mouth, almost at the edge of the peristome. Several bihamate spicules are also found in the buccal membrane. — DE MEIJERE says that the ophicephalous pedicellariæ do not present characteristic features; I cannot agree with him in this respect. They are of a very characteristic elongate form, narrow in the middle (Pl. VII. Fig. 43). The tridentate pedicellariæ (which were not found in the „Siboga“-specimen) are rather small (c. 0.8 mm., head); the valves are simple, widened in the outer part, with no meshwork in the bottom. The edge is finely serrate in the outer part, irregularly so in the lower part (Pl. VII. Fig. 34). The valves are widely separated, joining only with the outer part. — On the figure given

by BELL (Op. cit. Pl. XXVI. Fig. 3) the poriferous zone looks very peculiar, the pores being arranged in sets of two, and the porebearing plates being separated from the inner part of the ambulacral plate. This is wrongly drawn; the ambulacra are quite typically echinoid, with the pores arranged in distinct arcs of three.

„It is a somewhat difficult matter to suggest what are the nearest allies of this species“, says BELL. I think there can be no doubt that it is nearest allied to *verruculatus* among the *Psammechinus*-species, which species has likewise only small plates in the buccal membrane, though larger than in *Ps. rufus*, both differing in this respect very much from *Ps. variegatus*, where the buccal membrane is quite covered by thick plates. But on the other hand *Ps. rufus* reminds one of the *Gymnechinus*-species, especially of *G. pulchellus*, in which species a few small fenestrated plates may occur in the buccal membrane outside the buccal plates. Also the rather excentric periproct of *Ps. rufus* reminds one of the *Gymnechinus*-species of the *Robillardi*-group. It seems thus that *Ps. rufus* forms the transition from *Psammechinus* to *Gymnechinus*, and it might almost as well be referred to the latter genus; but it is most practical to refer it to *Psammechinus*, as otherwise the limits of these two genera would become indistinct — and these two genera must be maintained, as it would be rather absurd to unite the extreme forms, *Ps. variegatus* and *G. Robillardi* or *versicolor* into one genus.

In the collection of Echinids sent me from Prof. HARMER there are several specimens (naked tests) of *Psammechinus verruculatus* from the Sandwich Islands, which are peculiar by having the pore-areas and the adjoining part of the interambulacra (outside the primary tubercles) beautifully red coloured; also the usual greenish spots are found. On a specimen from Samoa (Hamburg Museum) preserved in alcohol, it is seen that the spines are white, with 1—4 narrow, red bands. In spite of this characteristic coloration this beautiful form can scarcely be regarded as distinct from *verruculatus*, no other differences being found. And among the specimens from the Sandwich-Islands there are some with the red colour faintly indicated and others without any indication of it. In one specimen with a few spines preserved these are violet at the base. — According to DE LORIOLE (Echinod. Maurice. p. 23) two ocular plates reach the periproct; this is the case in some of the specimens before me, in others, however, only one ocular plate reaches the periproct.

DE MEIJERE („Siboga“-Echinoidea p. 101) expresses his doubt of *Echinometra oblonga* being a distinct species, as he finds all transitional forms between *E. Matthæi* and *oblonga*. In the „Ingolf“-Echinoidea (p. 129) I have stated that *E. oblonga* agrees with the other species (*Incuniter* etc.) as regards spicules and pedicellariæ, mentioning only that it has a joint on the stalk of the globiferous pedicellariæ. In a letter to me Prof. DÖDERLEIN has called my attention to the fact that the *Echinometra oblonga* has, indeed, triradiate, not bihamate spicules in its tubefeet. My statement, that it has bihamate spicules, was occasioned by my having relied upon a determination of LÜTKEN. It was not my intention to work out more closely the

Echinometra-species, as they did not seem to present differences of greater interest, so I did not revise the determination of this species. What I took for *oblonga*, now proves to be *E. Matthæi* and thus my statements for *oblonga* are wrong. *E. oblonga* differs, indeed, very markedly from the other *Echinometra*-species in having triradiate spicules in the tube-feet (Pl. V. Fig. 26); bihamate spicules, however, may also occur together with the triradiate ones, and transitional forms between bihamate and triradiate may be found; also the tridentate pedicellariæ are characteristic (Pl. VII. Fig. 35), whereas the globiferous pedicellariæ are like those of the other species (*lucunter* etc.). (I have not examined the type-specimen.) This species thus is quite unique among the Echinometrids, which have otherwise bihamate spicules (only in *Selenechinus* de Meijere they are thorny), and must perhaps form a separate genus. I shall, however, not propose a name for it. The triradiate spicules can evidently not be regarded as a primitive feature; the transitional forms from the bihamate spicules seem to indicate that they are a further development from the bihamate ones. That would also agree with the fact of this species being the most elongate of all Echinometrids.

In his paper „Echinoderms from Puget Sound“ (Proc. Boston Soc. Nat. Hist. XXIX. 1901. p. 331) CLARK mentions *Echinometra oblonga* from that locality. This seems very improbable. The statement that *Astropyga pulvinata* and *Toxopneustes pileolus* occur on both sides of the Pacific has been proved to be erroneous, and it seems very doubtful if any littoral species does so. In any case a very close examination must be made of such species, before so wide a distribution can be accepted as a certain fact.

Mrs. R. I. Pocock has kindly undertaken the revision of the language in the present work. I beg her to accept my best thanks for this service.

Plate I.

- Fig. 1. *Chelodiadema granulatum*; abactinal side; a little diminished.
- 2. *Pleurechinus siamensis*; abactinal side. From a specimen 8 mm. in diameter.
- 3. *Chelodiadema granulatum*; actinal side. Same specimen as Fig. 1.
- 4. *Pleurechinus maculatus*; side view. Nat. size.
- 5. — *variegatus*; — — From a specimen 12 mm. in diameter.
- 6. — — abactinal side. Same specimen as Fig. 5.
- 7. — *siamensis*; — — From a specimen 12 mm. in diameter (from Torres Strait).
- 8. — *variegatus*; — — Nat. size.
- 9. — *scillæ*; side view. From a specimen 8.5 mm. in diameter (from New Britain).
- 10. — — — — — — — — (from Muscat).
- 11. — *siamensis*; side view. Same specimen as Fig. 7.
- 12. — *Döderleini*; — — From a specimen 11 mm. in diameter.
- 13. — — abactinal side. Same specimen as Fig. 12.
- 14. — *maculatus* — — — — — — — — 4.
- 15. *Opechinus spectabilis*; — — Nat. size.
- 16. *Gymnechinus pulchellus*; — — — — —
- 17. *Pleurechinus scillæ*; — — Same specimen as Fig. 10.
- 18. — — — — — — — — 9.
- 19. — *variegatus*; side view. Same specimen as Fig. 8.
- 20. — *siamensis*; — — — — — — — — 2.
- 21. *Chelodiadema granulatum*; actinal side. A little diminished.
- 22. — — abactinal side. Same specimen as Fig. 21.
- 23. *Gymnechinus pulchellus*; side view. Same specimen as Fig. 16.

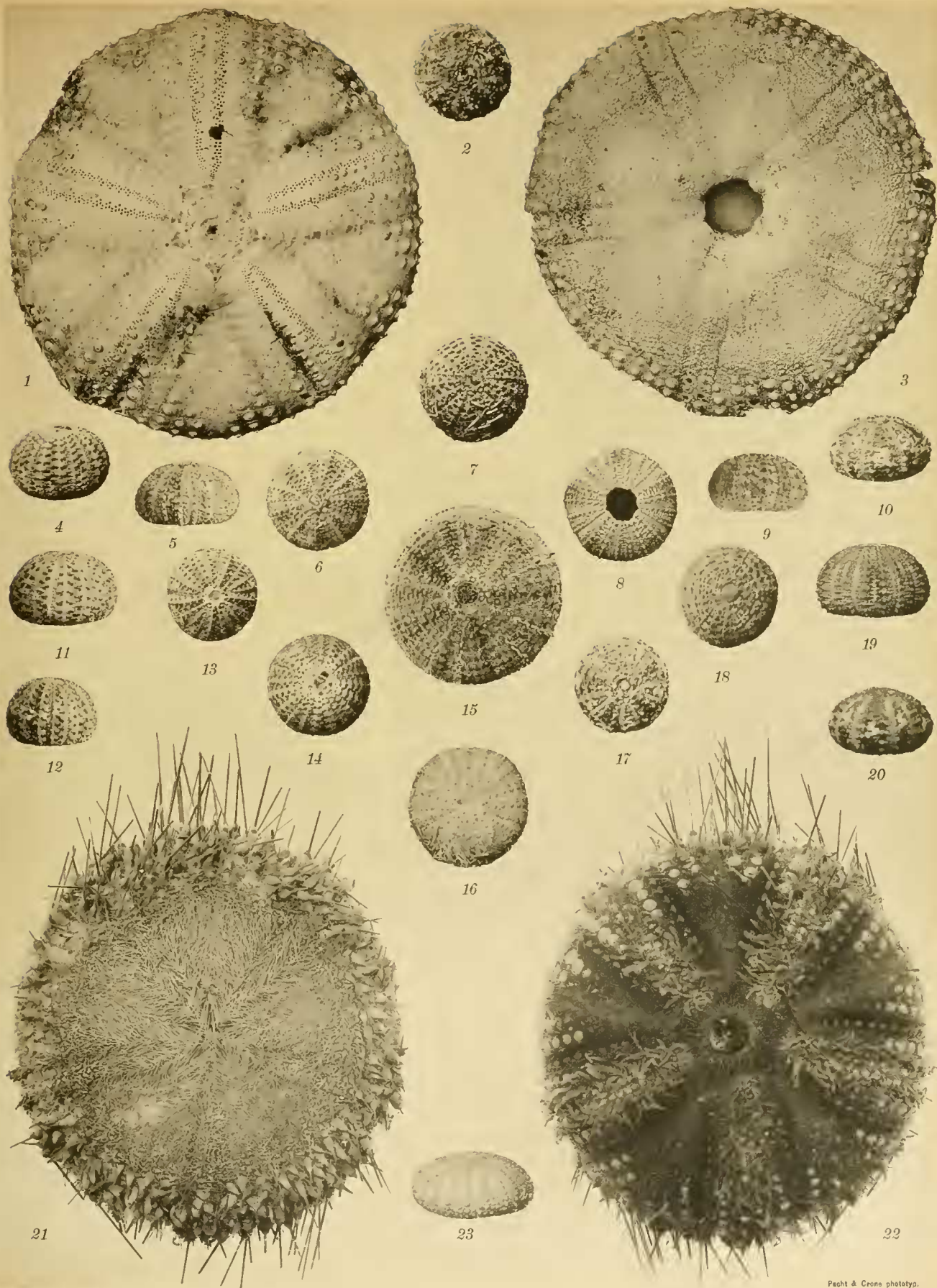


Plate II.

- _____

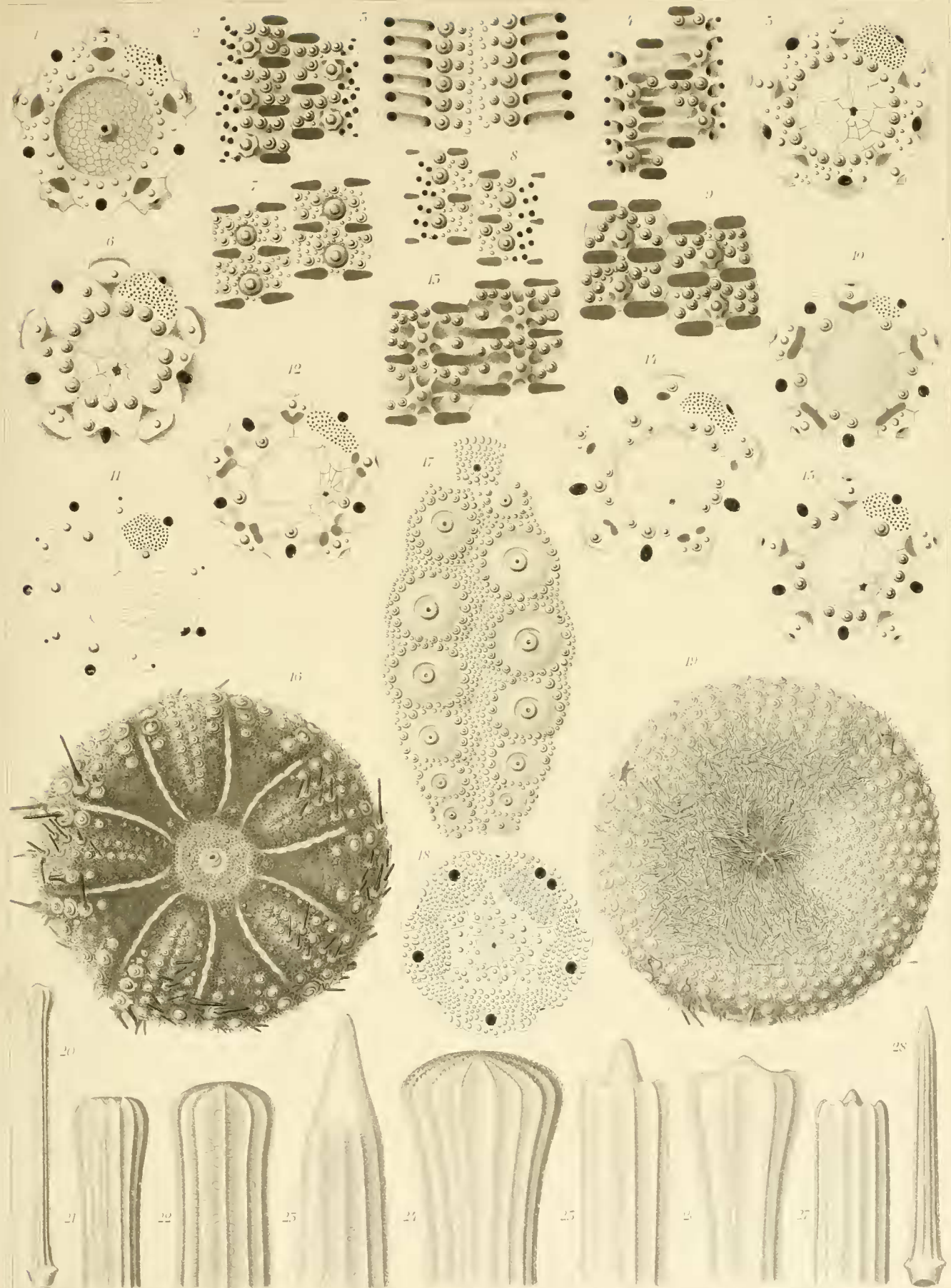


Plate III.

Diadema antillarum 1, 10, 16. *D. mexicanum* 2, 20. *D. Savignyi* 6, 8. *D. globulosum* 7. *D. saxatile* 22, 23, 29. *Centrostephanus Rodgersii* 4. *Astropyga radiata* 15, 19. *A. pulvinata* 3. *Chaetodiadema granulatum* 11. *Echinothrix diadema* 9, 14, 24, 27. *E. calmaris* 5, 13, 17, 21, 30. *Aspidodiadema Jacobyi* 25. *A. tonsum* 26. *Plesiadiadema antillarum* 18. *Pl. microtuberculatum* 28. *Cenopedina mirabilis* 12.

- Fig. 1. Valve of large tridentate pedicellaria of *Diadema antillarum*. Zeiss. AA. Oc. 2.
 — 2. — - small — — — — *mexicanum*. — — 3.
 — 3. — - tridentate pedicellaria of *Astropyga pulvinata*. Zeiss. AA. Oc. 3.
 — 4. — - ophicephalous — — *Centrostephanus Rodgersii*. Seibert. Obj. II. Oc. 0.
 — 5. — - tridentate — — large form, of *Echinothrix calamaris*. Seib. Obj. II. Oc. 1.
 — 6. — - — — small — from the buccal membrane of *Diadema Savignyi*;
 side view (comp. Pl. V. 24). Zeiss. Apochr. 8·0. Comp. Oc. 4.
 — 7. Valve of tridentate pedicellaria of *Diadema globulosum*. Zeiss. AA. Oc. 2,
 — 8. — - — — large form, of *Diadema Savignyi*. Zeiss. AA. Oc. 1.
 — 9. Tridentate pedicellaria, large form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
 — 10. Valve of tridentate pedicellaria, small form, of *Diadema antillarum*; front view (comp. Pl. V.
 13). Zeiss. AA. Oc. 3.
 — 11. Valve of ophicephalous pedicellaria of *Chaetodiadema granulatum*. Zeiss. D. Oc. 1.
 — 12. — - tridentate pedicellaria of *Cenopedina mirabilis*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
 — 13. Tridentate pedicellaria, large form, of *Echinothrix calamaris*. Seib. Obj. 0. Oc. 0.
 — 14. Valve of tridentate pedicellaria, large form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
 — 15. — - — — (1 form, small), of *Astropyga radiata*. — —
 — 16. — - ophicephalous — — of *Diadema antillarum*. Zeiss. D. Oc. 1.
 — 17. Spicules from tube feet of *Echinothrix calamaris*. Zeiss. AA. Oc. 1.
 — 18. Valve of ophicephalous pedicellaria, small form, of *Aspidodiadema antillarum* („*microtubercu-*
 latum“, „Challenger“, st 122). Seib. Obj. II. Oc. III.
 — 19. Valve of tridentate pedicellaria (II. form) of *Astropyga radiata*. Zeiss. AA. Oc. 3.
 — 20. — - — — large form, of *Diadema mexicanum*. — — 2.
 — 21. — - — — small — - *Echinothrix calamaris*. Seib. Obj. II. Oc. 1.
 — 22. — - — — large — - *Diadema saxatile*; side view. Zeiss. AA. Oc. 1.
 — 23. Tridentate pedicellaria, small form, of *Diadema saxatile*. Zeiss. Apochr. 16·0. Comp. Oc. 2.
 — 24. Spicule from tube foot of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
 — 25. Valve of an ophicephalous pedicellaria, large form, of *Aspidodiadema Jacobyi*. Zeiss. AA. Oc. 1.
 — 26. — — — — — — — — *tonsum*. Seib. Obj. II. Oc. 0.
 — 27. Spicules from tube foot of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
 — 28. Tridentate pedicellaria of *Plesiadiadema microtuberculatum* („Challenger“, st 134). Zeiss. AA. Oc. 2.
 — 29. Valve of tridentate pedicellaria, large form, of *Diadema saxatile*, from the inside. — — 1.
 — 30. — - — — — — — — *Echinothrix calamaris*. Seib. Obj. 0. Oc. III.

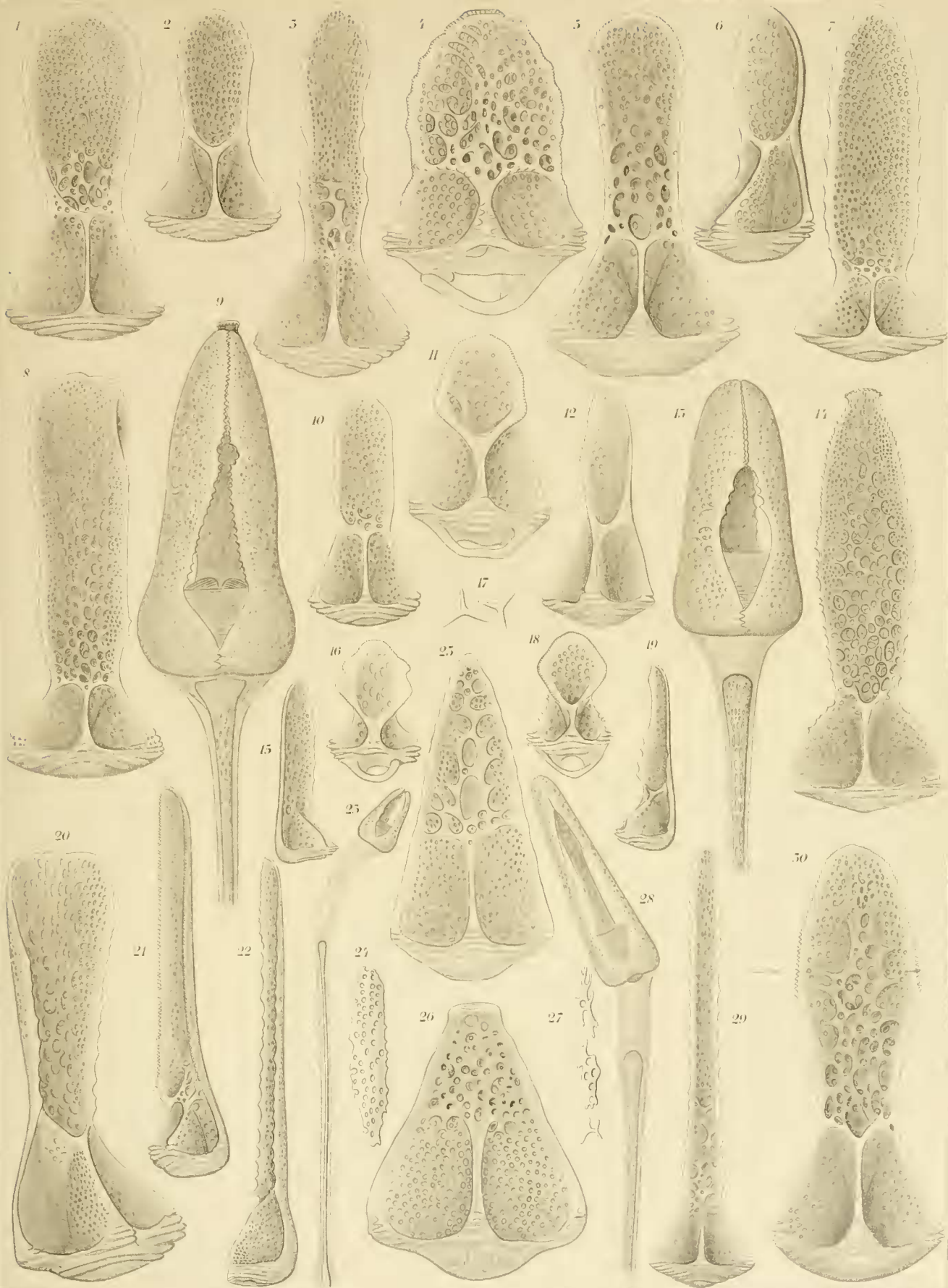


Plate IV.

Stephanocidaris bispinosa 30. *Plesiadiadema antillarum* 8, 16, 29, 33, 35. *Pl. microtuberculatum* 12, 18. *Aspidodiadema Jacobyi* 10, 20. *Diadema antillarum* 28. *D. Savignyi* 37. *D. saxatile* 26, 31, 34. *Astropyga radiata* 9, 17. *A. pulvinata* 21. *Chaetodiadema granulatum* 1, 4, 13, 14, 15, 24, 32. *Echinothrix calamaris* 7. *E. diadema* 23, 25, 36. *Centrostephanus longispinus* 2, 11. *C. Rodgersii* 19, 22. *Micropyga tuberculata* 27. *Cænopedina mirabilis* 3, 5, 6.

- Fig. 1. Tridentate pedicellaria of *Chaetodiadema granulatum*. Zeiss. AA. Oc. 1.
 2. Valve of ophicephalous pedicellaria of *Centrostephanus longispinus*. Seib. Obj. II. Oc. 1.
 — 3. — - globiferous pedicellaria of *Cænopedina mirabilis*; side view. Zeiss. D. Oc. 1.
 — 4. „Claviform“ pedicellaria, small form, of *Chaetodiadema granulatum* (comp. Fig. 32). Zeiss. a*. Oc. 3.
 — 5. Valve of globiferous pedicellaria of *Cænopedina mirabilis*; front view. Zeiss. D. Oc. 1.
 6. — - ophicephalous — — — — — Zeiss. Apochr. 8·0. Comp. Oc. 4.
 — 7. Tridentate pedicellaria, small form, of *Echinothrix calamaris*. Seib. Obj. 0. Oc. III.
 — 8. Valve of ophicephalous pedicellaria, large form, of *Plesiadiadema antillarum*. Seib. Obj. II. Oc. 1.
 — 9. Spicules from tube foot of *Astropyga radiata*. Zeiss. AA. Oc. 2.
 10. Valve of ophicephalous pedicellaria, small form, of *Aspidodiadema Jacobyi*. Zeiss. D. Oc. 1.
 11. — - globiferous (claviform) pedicellaria of *Centrostephanus longispinus*. Seib. Obj. II. Oc. III.
 — 12. — - ophicephalous pedicellaria, small form, of *Plesiadiadema microtuberculatum*. Zeiss. D. Oc. 1.
 — 13. Spicules of *Chaetodiadema granulatum*; a. from abactinal, b. from buccal tube foot. Zeiss. D. Oc. 1.
 — 14. Actinal spine of *Chaetodiadema granulatum*. ¹⁶/₁.
 — 15. Spicules of *Chaetodiadema granulatum*; from actinal tube foot. Zeiss. D. Oc. 1.
 — 16. Valve of triphyllous pedicellaria of *Plesiadiadema antillarum*. Seib. Obj. II. Oc. III.
 17. — - — — — - *Astropyga radiata*. Zeiss. D. Oc. 1.
 — 18. — - — — — - *Plesiadiadema microtuberculatum*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
 — 19. Valve of globiferous pedicellaria of *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. 0.
 20. — - triphyllous — - *Aspidodiadema Jacobyi*. Zeiss. D. Oc. 1.
 — 21. — - — — — - *Astropyga pulvinata*. Zeiss. D. Oc. 1.
 — 22. — - — — — - *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. 1.
 23. — - — — — - *Echinothrix diadema*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
 — 24. — - — — — - *Chaetodiadema granulatum*. Zeiss. D. Oc. 1.
 25. Tridentate pedicellaria, small form, of *Echinothrix diadema*. Zeiss. AA. Oc. 1.
 — 26. Valve of triphyllous pedicellaria of *Diadema saxatile*. D. Oc. 2.
 — 27. — - — — — - *Micropyga tuberculata*. Zeiss. D. Oc. 1.
 28. Tridentate pedicellaria, large form, of *Diadema antillarum*. Zeiss. Apochr. 16·0. Comp. Oc. 2.
 — 29. Valve of tridentate pedicellaria of *Plesiadiadema antillarum*. Zeiss. AA. Oc. 3.
 — 30. — - — — — - *Stephanocidaris bispinosa*. Zeiss. AA. Oc. 2.
 31. Stalk of pedicellaria of *Diadema saxatile*. Zeiss. A. Oc. 3.
 32. „Claviform“ pedicellaria of *Chaetodiadema granulatum*. Zeiss. a*. Oc. 3. (Comp. Fig. 4.)
 — 33. — — — — — - *Plesiadiadema antillarum*. Zeiss. AA. Oc. 2.
 — 34. Stalk of pedicellaria of *Diadema saxatile*. Zeiss. AA. Oc. 2.
 35. Valve of triphyllous pedicellaria of *Plesiadiadema antillarum* („*Aspidod. microtuberculatum*“.
 Chall. Macio.). Seib. Obj. II. Oc. 1.
 — 36. Valve of tridentate pedicellaria, small form, of *Echinothrix diadema*. Zeiss. AA. Oc. 3.
 — 37. Tridentate pedicellaria, small form, of *Diadema Savignyi*. Zeiss. Apochr. 16·0. Oc. 2.

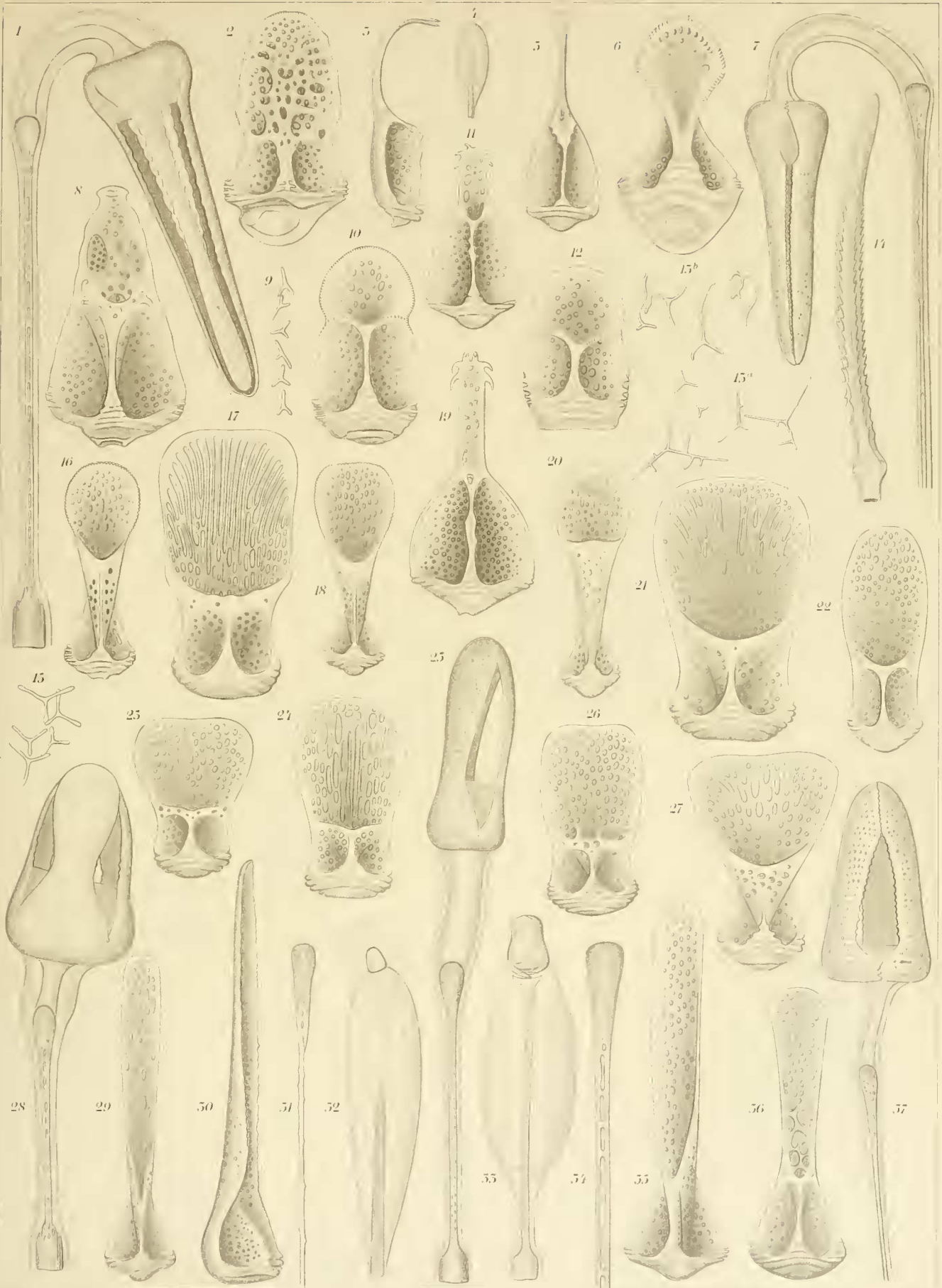


Plate V.

Stephanocidaris bispinosa 20, 25. Plesiodiadema antillarum 4, 32. Pl. microtuberculatum 30. Aspidodiadema tonsum 6, 31. A. Jacobyi 28. Diadema antillarum 13. D. mexicanum 1. D. Savignyi 7, 9, 24. D. saxatile 2, 5, 8, 12, 14, 15. Astropyga radiata 27. Chaetodiadema granulatum 10, 18, 19, 22, 35. Echinothrix calamaris 3, 11. Centrostephanus longispinus 29. C. Rodgersii 34. Micropyga tuberculata 33, 37. Opechinus spectabilis 21. Salmacis sphaeroides 23. Microcyphus annulatus 17. Psammechinus rufus 16. Parasalenia gratiosa 36. Echinometra oblonga 26.

- Fig. 1. Tridentate pedicellaria, large form, of *Diadema mexicanum*. Zeiss. Apochr. 16·0. Oc. 2.
 2. — — — — — *saxatile*. Zeiss. Apochr. 16·0. Oc. 2.
 3. Valve of tridentate pedicellaria, small form, of *Echinothrix calamaris*. Seib. Obj. II. Oc. I.
 4. Ophicephalous pedicellaria, large form, of *Plesiodiadema antillarum*. Zeiss. AA. Oc. 3.
 5. Valve of tridentate pedicellaria, small form, of *Diadema saxatile*; front view (comp. Fig. 8). Zeiss. AA. Oc. 3.
 6. Tridentate pedicellaria of *Aspidodiadema tonsum*. Zeiss. AA. Oc. 3.
 7. — — — — — large form, of *Diadema Savignyi*. Zeiss. Apochr. 16·0. Comp. Oc. 2.
 8. Valve of tridentate pedicellaria, small form, of *Diadema saxatile*; side view (comp. Fig. 5). Zeiss. AA. Oc. 3.
 9. Valve of tridentate pedicellaria, small form, of *Diadema Savignyi*. Zeiss. AA. Oc. 2.
 10. Spine of *Chaetodiadema granulatum*; basal part. "1.
 11. Valve of ophicephalous pedicellaria of *Echinothrix calamaris*. Zeiss. Apochr. 8·0. Comp. Oc. 4.
 12. Spicules from the partition wall of abactinal tubefoot of *Diadema saxatile*. Zeiss. AA. Oc. 1.
 13. Valve of tridentate pedicellaria, small form, of *Diadema antillarum*; side view (comp. Pl. III. 10). Zeiss. AA. Oc. 3.
 14. Valve of tridentate pedicellaria of *Diadema saxatile*; side view (comp. Fig. 15). Zeiss. AA. Oc. 3.
 15. — — — — — front — (— 14). — — 2.
 16. Plates and spicules from buccal membrane of *Psammechinus rufus*; in the natural position. Zeiss. AA. Oc. 3.
 17. Plate from buccal membrane of *Microcyphus annulatus*. Zeiss. Apochr. 8·0. Comp. Oc. 2.
 18. Transverse section of the outer end of a large actual spine of *Chaetodiadema granulatum*. Zeiss. AA. Oc. 3.
 19. Transverse section of large abactinal spine of *Chaetodiadema granulatum*. Zeiss. AA. Oc. 3.
 20. Spicules from the genital organs of *Stephanocidaris bispinosa*. Zeiss. D. Oc. 1.
 21. — — — — — buccal membrane of *Opechinus spectabilis*; natural position. Zeiss. D. Oc. 1.
 22. Valve of small tridentate pedicellaria of *Chaetodiadema granulatum* (comp. Fig. 35). Zeiss. AA. Oc. 3.
 23. Spicules of *Salmacis sphaeroides*; a, c. from the genital organs. b. from the stone canal. Zeiss. Apochr. 8·0. Comp. Oc. 4.
 24. Valve of small tridentate pedicellaria from the buccal membrane of *Diadema Savignyi*; front view (comp. Pl. III. 6). Zeiss. Apochr. 8·0. Comp. Oc. 4.
 25. Spicules from the intestine of *Stephanocidaris bispinosa*. Zeiss. D. Oc. 1.
 26. — — — — — tube foot of *Echinometra oblonga*. Zeiss. D. Oc. 1.
 27. Valve of tridentate pedicellaria, large form, of *Astropyga radiata*. Zeiss. AA. Oc. 1.
 28. — — — — — of *Aspidodiadema Jacobyi*. Zeiss. AA. Oc. 3.
 29. — — — — — *Centrostephanus longispinus*. Seib. Obj. 0. Oc. 0.
 30. — — — — — *Plesiodiadema microtuberculatum*. Zeiss. AA. Oc. 2.
 31. Triphyllous pedicellaria of *Aspidodiadema tonsum*. Zeiss. AA. Oc. 3.
 32. Ophicephalous — — — — — small form, of *Plesiodiadema antillarum*. Zeiss. AA. Oc. 3.
 33. Valve of small tridentate pedicellaria of *Micropyga tuberculata* (comp. Fig. 37). Zeiss. AA. Oc. 3.
 34. — — — — — tridentate pedicellaria of *Centrostephanus Rodgersii*. Seib. Obj. II. Oc. 0.
 35. — — — — — *Chaetodiadema granulatum* (comp. Fig. 22). Zeiss. AA. Oc. 1.
 36. — — — — — *Parasalenia gratiosa*. Zeiss. AA. Oc. 1.
 37. — — — — — *Micropyga tuberculata* (comp. Fig. 33). Zeiss. AA. Oc. 1.



Plate VI.

Opechinus variabilis 27. *O. spectabilis* 42. *Temnopleurus toreumaticus* 8, 14, 22, 49. *T. Hardwickii* 32, 34. *T. Reevesii* 3, 10, 12. *Salmacis sphaeroides* 1, 11, 41. *S. bicolor* 2, 4, 23, 26, 39, 40. *S. virgulata* 7, 18, 46, 47. *Pleurechinus bothryoides* 5, 6, 38. *Pl. maculatus* 20, 44. *Pl. siamensis* 16, 36. *Pl. scillæ* 13. *Pl. ruber* 28. *Pl. Döderleini* 35, 43. *Salmacopsis olivacea* 25, 30. *Microcyphus maculatus* 19. *M. annulatus* 15, 29, 31. *M. elegans* 24. *Mespilia globulus* 17. *Amblypneustes formosus* 9, 37. *A. pallidus* 48. *A. grossularia* 21, 33. *Gymnechinus inconspicuus* 45.

For all the figures of this plate a Zeiss instrument was used.

- Fig 1. Tridentate pedicellaria of *Salmacis sphaeroides*. AA. Oc. 1.
 — 2. Valve of globiferous pedicellaria of *Salmacis bicolor* (comp. large form Fig. 26). AA. Oc. 3.
 — 3. — — — — — *Temnopleurus Reevesii*; side view (comp. Fig. 10). Apochr. 8.0. Oc. 1.
 — 4. Valve of ophicephalous pedicellaria of *Salmacis bicolor*. AA. Oc. 3.
 — 5. — — globiferous — — *Pleurechinus bothryoides*; side view. D. Oc. 1.
 — 6. — — — — — front — — —
 — 7. Tridentate pedicellaria of *Salmacis virgulata*. AA. Oc. 1.
 — 8. Valve of globiferous pedicellaria of *Temnopleurus toreumaticus*; side view (comp. Fig. 14). Apochr. 8.0. Oc. 1.
 — 9. Valve of ophicephalous pedicellaria of *Amblypneustes formosus*. Apochr. 8.0. Oc. 1.
 — 10. — — globiferous — — *Temnopleurus Reevesii*; front view (comp. Fig. 3). Apochr. 8.0. Oc. 1.
 — 11. Valve of globiferous pedicellaria of *Salmacis sphaeroides*. AA. Oc. 2.
 — 12. — — ophicephalous — — *Temnopleurus Reevesii*. Apochr. 3.0. Oc. 1.
 — 13. — — globiferous — — *Pleurechinus scillæ*. D. Oc. 1.
 — 14. — — — — — *Temnopleurus toreumaticus*; front view (comp. Fig. 8). Apochr. 8.0. Oc. 1.
 — 15. Valve of ophicephalous pedicellaria of *Microcyphus annulatus*. Apochr. 8.0. Oc. 1.
 — 16. Spicules from buccal membrane of *Pleurechinus siamensis*. D. Oc. 1.
 — 17. Valve of triphyllous pedicellaria of *Mespilia globulus*. D. Oc. 2.
 — 18. — — globiferous — — *Salmacis virgulata*. AA. Oc. 2.
 — 19. — — — — — *Microcyphus maculatus*; side view (comp. Pl. VII. 20). Apochr. 8.0. Oc. 1.
 — 20. Valve of globiferous pedicellaria of *Pleurechinus maculatus*; side view (comp. Pl. VII. 17). D. Oc. 1.
 — 21. Valve of triphyllous pedicellaria of *Amblypneustes grossularia*. D. Oc. 1.
 — 22. — — ophicephalous — — *Temnopleurus toreumaticus*. Apochr. 8.0. Comp. Oc. 4.
 — 23. — — triphyllous — — *Salmacis bicolor*. Apochr. 8.0. Comp. Oc. 4.
 — 24. — — globiferous — — *Microcyphus elegans*; side view (comp. Pl. VII. 38). D. Oc. 1.
 — 25. Valve of globiferous pedicellaria of *Salmacopsis olivacea*; side view (comp. Fig. 30). Apochr. 8.0. Comp. Oc. 4.
 — 26. Valve of globiferous pedicellaria, large form, of *Salmacis bicolor* (comp. Fig. 2). AA. Oc. 3.
 — 27. — — — — — of *Opechinus variabilis*; side view (comp. Pl. VII. 2). Apochr. 8.0. Comp. Oc. 4.
 — 28. Valve of globiferous pedicellaria of *Pleurechinus ruber*; side view (comp. Pl. VII. 6). D. Oc. 1.
 — 29. — — — — — *Microcyphus annulatus*; side view (comp. Fig. 31). D. Oc. 1.
 — 30. — — — — — *Salmacopsis olivacea*; front view (comp. Fig. 25). Apochr. 8.0. Comp. Oc. 4.
 — 31. Valve of globiferous pedicellaria of *Microcyphus annulatus*; front view (comp. Fig. 29). D. Oc. 1.
 — 32. — — ophicephalous — — *Temnopleurus Hardwickii*. Apochr. 8.0. Oc. 1.
 — 33. — — globiferous — — *Amblypneustes grossularia*. AA. Oc. 3.
 — 34. — — — — — *Temnopleurus Hardwickii*; front view (comp. Pl. VII. 21). Apochr. 8.0. Oc. 1.
 — 35. Valve of globiferous pedicellaria of *Pleurechinus Döderleini*; side view (comp. Pl. VII. 10). D. Oc. 1.
 — 36. — — — — — *siamensis*; — — (— Pl. VII. 14). —
 — 37. — — — — — *Amblypneustes formosus*; — — (— Pl. VII. 4). —
 — 38. Tridentate pedicellaria of *Pleurechinus bothryoides*. Apochr. 8.0. Oc. 1.
 — 39. Valve of small tridentate pedicellaria of *Salmacis bicolor*. AA. Oc. 3.
 — 40. — — large — — — — — (comp. Pl. VII. 1). AA. Oc. 2.
 — 41. — — tridentate pedicellaria of *Salmacis sphaeroides*. AA. Oc. 2.
 — 42. — — — — — *Opechinus spectabilis*. Apochr. 8.0. Oc. 1.
 — 43. — — triphyllous — — *Pleurechinus Döderleini*. D. Oc. 2.
 — 44. — — — — — *maculatus* — — 1.
 — 45. — — tridentate — — *Gymnechinus inconspicuus*. D. Oc. 1.
 — 46. — — — — — *Salmacis virgulata*; side view. AA. Oc. 3.
 — 47. — — — — — front — — —
 — 48. — — — — — *Amblypneustes pallidus*. Apochr. 8.0. Comp. Oc. 4.
 — 49. Tridentate pedicellaria of *Temnopleurus toreumaticus*. AA. Oc. 1.

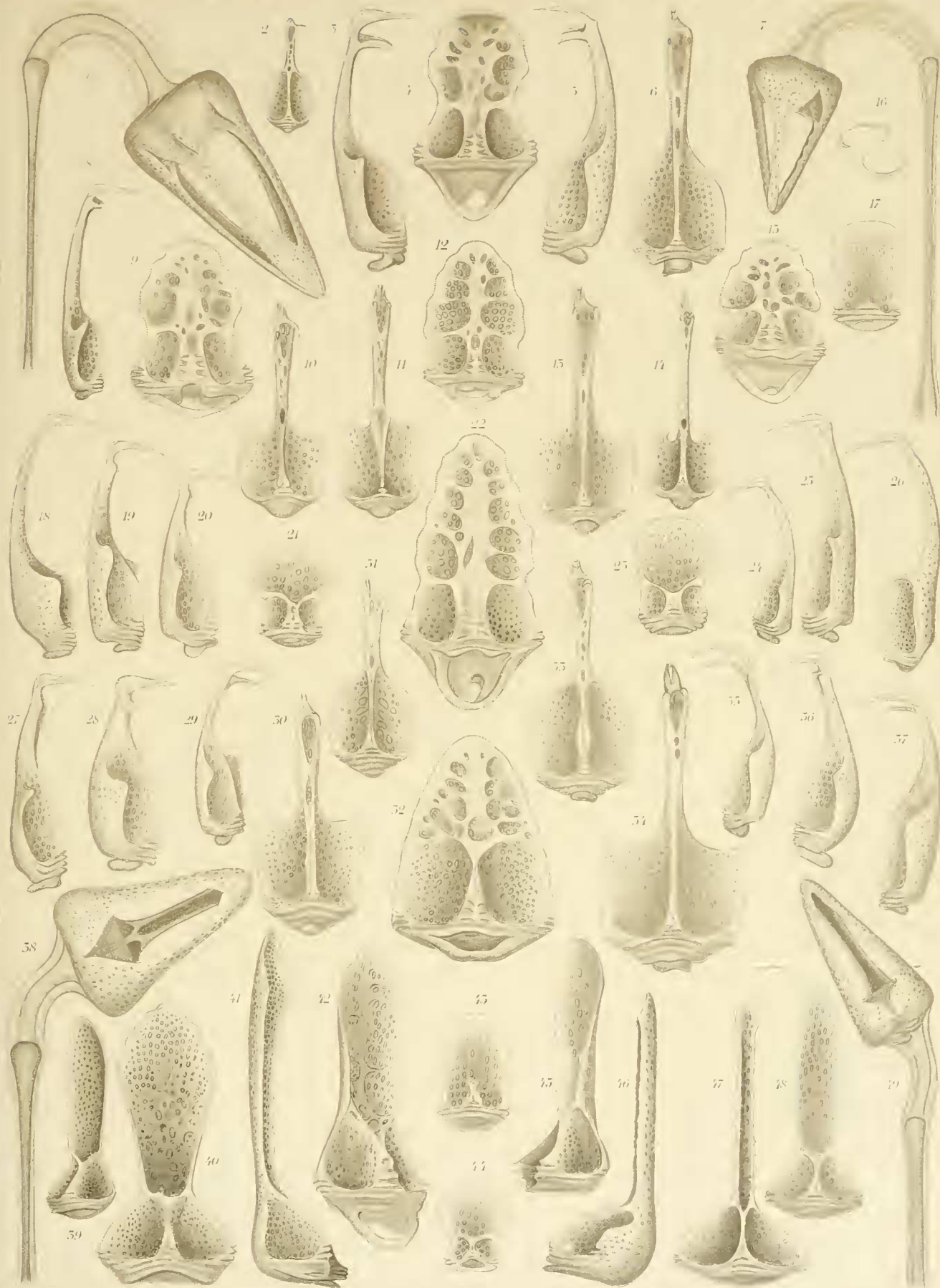
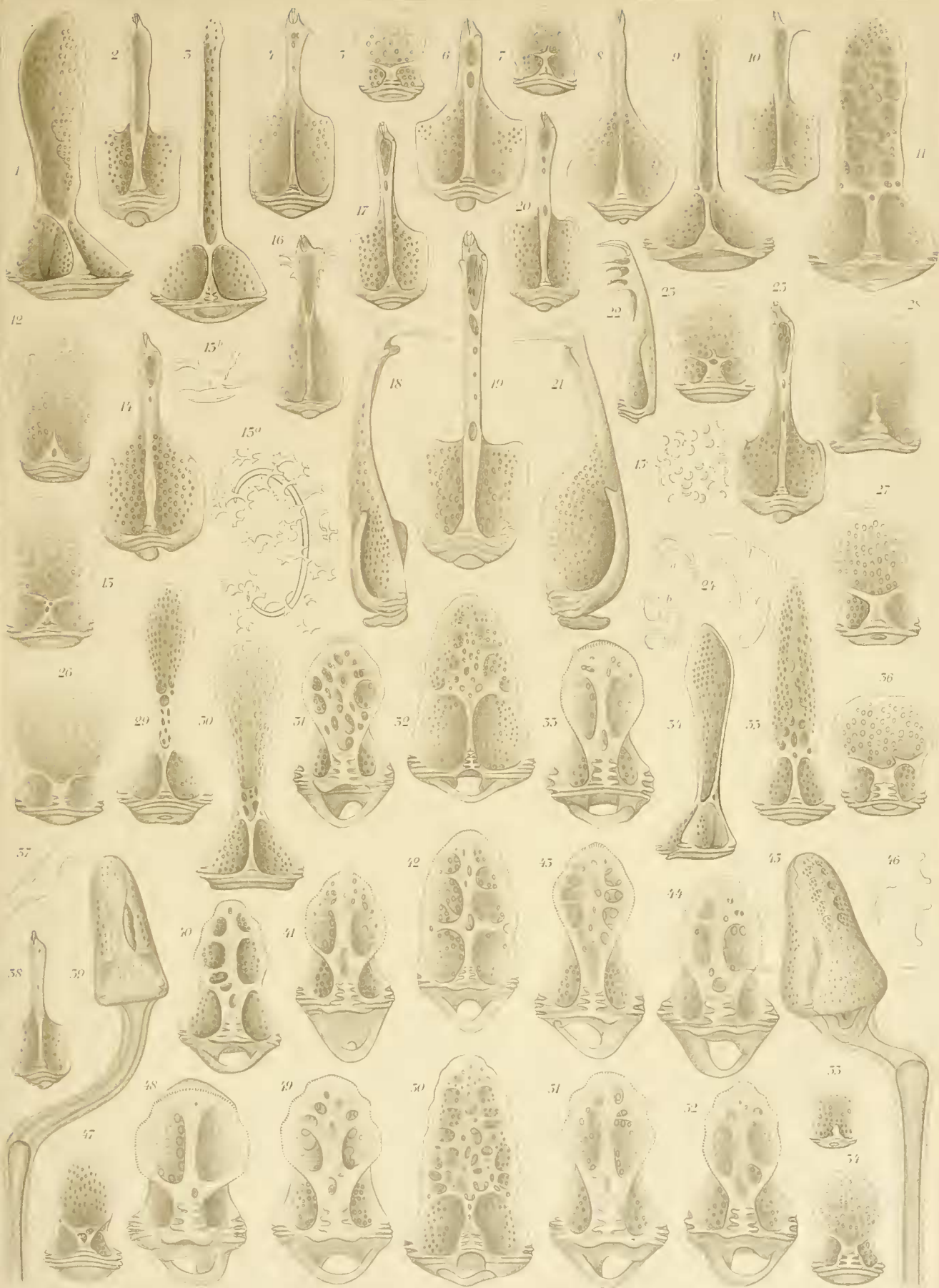


Plate VII.

Opechinus variabilis 2, 7, 49. *O. spectabilis* 18, 19, 27, 45. *Temnopleurus toreumaticus* 3, 28. *T. Hardwickii* 21. *T. Reevesii* 37. *Salmacis bicolor* 1. *S. virgulata* 40. *S. dussumieri* 15. *Pleurechinus bothryoides* 5, 9, 51. *Pl. maculatus* 17. *Pl. siamensis* 14, 44, 53. *Pl. similis* 25. *Pl. ruber* 6. *Pl. Döderleini* 10, 48. *Salmacopsis olivacea* 23. *Mespilia globulus* 16, 22, 33, 47. *Microcyphus maculatus* 20, 31. *M. elegans* 38. *Amblypneustes formosus* 4, 13. *A. ovum* 11, 50. *A. pallidus* 12, 42. *A. grossularia* 52. *Holopneustes purpurascens* 32. *Psammechinus rufus* 34, 43. *Gymnechinus pulchellus* 8, 29, 36, 41, 46. *G. versicolor* 24, 26, 30. *G. inconspicuus* 39, 54. *Echinometra oblonga* 35.

For all the figures of this plate a Zeiss instrument was used.

- Fig. 1. Valve of tridentate pedicellaria, large form, of *Salmacis bicolor* (comp. Pl. VI. 40). AA. Oc. 2.
 — 2. — - globiferous — of *Opechinus variabilis*; front view (comp. Pl. VI. 27). Apochr. 8.0. Comp. Oc. 4.
 — 3. Valve of tridentate pedicellaria of *Temnopleurus toreumaticus*. AA. Oc. 3.
 — 4. — - globiferous — - *Amblypneustes formosus*; front view (comp. Pl. VI. 37). D. Oc. 1.
 — 5. — - triphyllous — - *Pleurechinus bothryoides*. D. Oc. 1.
 — 6. — - globiferous — - *ruber*; front view (comp. Pl. VI. 28). D. Oc. 1.
 — 7. — - triphyllous — - *Opechinus variabilis*. Apochr. 8.0. Comp. Oc. 4.
 — 8. — - globiferous — - *Gymnechinus pulchellus* — —
 — 9. — - tridentate — - *Pleurechinus bothryoides*. — —
 — 10. — - globiferous — - *Döderleini*; front view (comp. Pl. VI. 35). D. Oc. 1.
 — 11. — - tridentate — - *Amblypneustes ovum*. AA. Oc. 3.
 — 12. — - triphyllous — - *pallidus*. D. Oc. 1.
 — 13. — - — — - *formosus* — —
 — 14. — - globiferous — - *Pleurechinus siamensis*; front view (comp. Pl. VI. 36). D. Oc. 1.
 — 15. Spicules from *Salmacis dussumieri*; a. from genital organs, b from stone canal, c. from intestine. Apochr. 8.0. Comp. Oc. 4.
 — 16. Valve of globiferous pedicellaria of *Mespilia globulus*; front view (comp. Fig. 22). D. Oc. 1.
 — 17. — - — — - *Pleurechinus maculatus*; front view. comp. Pl. VI. 20). D. Oc. 1.
 — 18. — - — — - *Opechinus spectabilis*; side view. Apochr. 8.0. Oc. 2.
 — 19. — - — — - — — front — —
 — 20. — - — — - *Microcyphus maculatus*; front view (comp. Pl. VI. 19). Apochr. 8.0. Oc. 1.
 — 21. Valve of globiferous pedicellaria of *Temnopleurus Hardwickii*; side view (comp. Pl. VI. 34). Apochr. 8.0. Oc. 1.
 — 22. Valve of globiferous pedicellaria of *Mespilia globulus*; side view (comp. Fig. 16). D. Oc. 1.
 — 23. — - triphyllous — - *Salmacopsis olivacea*. D. Oc. 1.
 — 24. Spicules of *Gymnechinus versicolor*; a. from buccal membrane, b. from ophicephalous pedicellaria, c. from tube feet; d. from globiferous pedicellaria. D. Oc. 3.
 — 25. Valve of globiferous pedicellaria of *Pleurechinus scille*. D. Oc. 1.
 — 26. — - triphyllous — - *Gymnechinus versicolor*. D. Oc. 1.
 — 27. — - — — - *Opechinus spectabilis*. D. Oc. 1.
 — 28. — - — — - *Temnopleurus toreumaticus*. D. Oc. 1.
 — 29. — - tridentate — - *Gymnechinus pulchellus*. AA. Oc. 3.
 — 30. — - — — - *versicolor* — —
 — 31. — - ophicephalous — - *Microcyphus maculatus*. Apochr. 8.0. Oc. 1.
 — 32. — - — — - *Holopneustes purpurascens*. AA. Oc. 3.
 — 33. — - — — - *Mespilia globulus*. Apochr. 8.0. Oc. 1.
 — 34. — - tridentate — - *Psammechinus rufus*. AA. Oc. 2.
 — 35. — - — — - *Echinometra oblonga*. AA. Oc. 3.
 — 36. — - triphyllous — - *Gymnechinus pulchellus*. D. Oc. 1.
 — 37. Spicules from tube foot of *Temnopleurus Reevesii*. Apochr. 8.0. Comp. Oc. 1.
 — 38. Valve of globiferous pedicellaria of *Microcyphus elegans*; front view (comp. Pl. VI. 24.). D. Oc. 1.
 — 39. Tridentate pedicellaria of *Gymnechinus inconspicuus*. Apochr. 8.0. Oc. 1.
 — 40. Valve of ophicephalous pedicellaria of *Salmacis virgulata*. AA. Oc. 3.
 — 41. — - — — - *Gymnechinus pulchellus*. Apochr. 8.0. Comp. Oc. 4.
 — 42. — - — — - *Amblypneustes pallidus*. — —
 — 43. — - — — - *Psammechinus rufus*. Apochr. 8.0. Comp. Oc. 4.
 — 44. — - — — - *Pleurechinus siamensis*. D. Oc. 1.
 — 45. Tridentate pedicellaria of *Opechinus spectabilis*. AA. Oc. 3.
 — 46. Spicules from globiferous pedicellaria of *Gymnechinus pulchellus*. D. Oc. 3.
 — 47. Valve of tridentate pedicellaria of *Mespilia globulus*. D. Oc. 1.
 — 48. — - ophicephalous — - *Pleurechinus Döderleini*. D. Oc. 1.
 — 49. — - — — - *Opechinus variabilis*. Apochr. 8.0. Comp. Oc. 4.
 — 50. — - — — - *Amblypneustes ovum*. AA. Oc. 3.
 — 51. — - — — - *Pleurechinus bothryoides*. Apochr. 8.0. Comp. Oc. 4.
 — 52. — - — — - *Amblypneustes grossularia*. — —
 — 53. — - triphyllous — - *Pleurechinus siamensis*. D. Oc. 1.
 — 54. — - — — - *Gymnechinus inconspicuus*. D. Oc. 1.



101° E. fr Greenwich

PART of

GULF of SIAM



NOTES

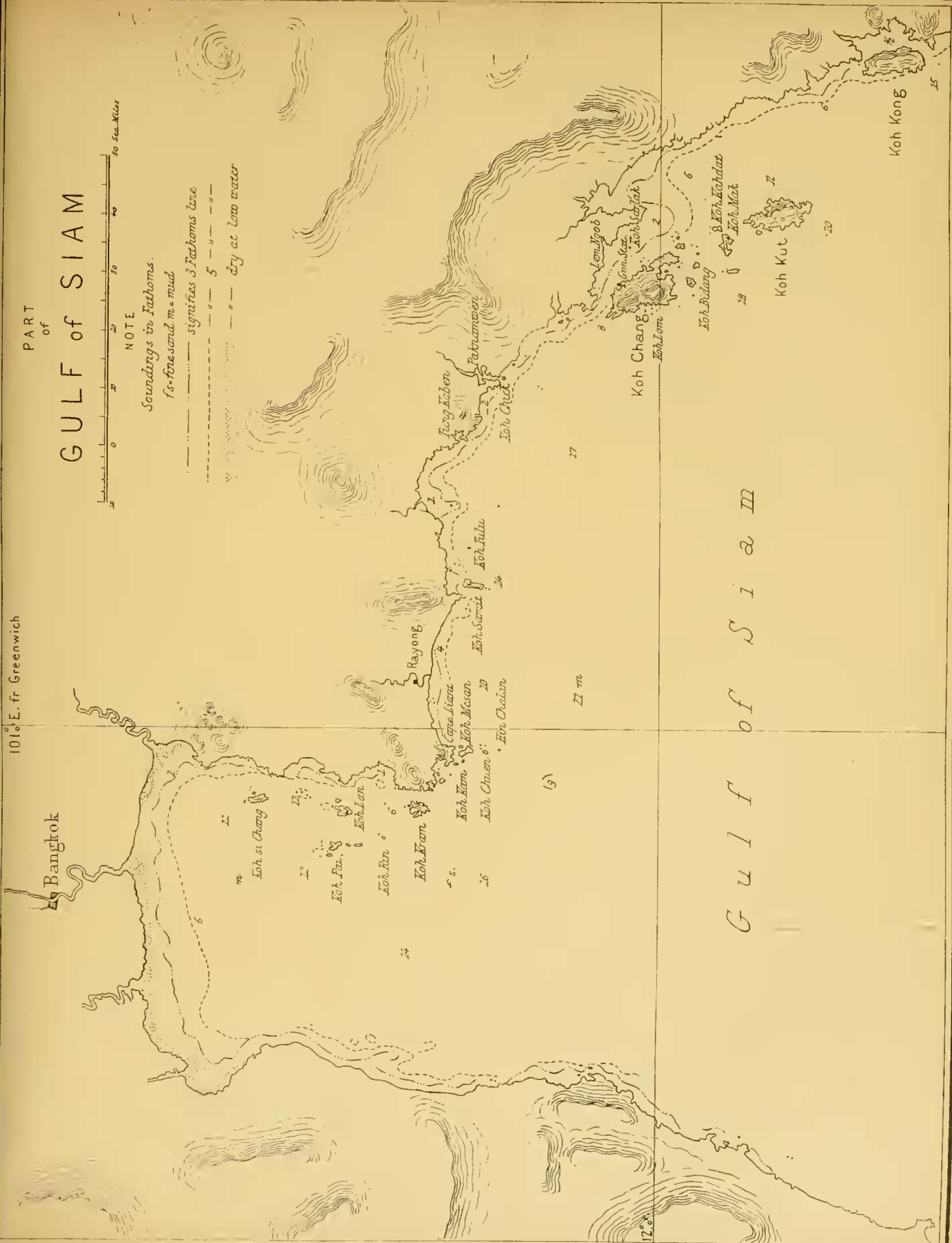
Soundings in Fathoms.

fs = fine sand. m = mud

signifies 3 Fathoms line

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Guelf of Sicily

Koh Kong

OM MUSKLERNES BEFÆSTELSE TIL DET YDRE SKELET HOS LEDDYRENE

AF

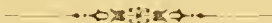
R. H. STAMM,

MAG. SC., ASSISTENT VED UNIVERSITETETS HISTOLOGISK-EMBRYOLOGISKE LABORATORIUM

MED 2 TAVLER

RÉSUMÉ EN FRANÇAIS

D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, 7. REKKE, NATURVIDENSK. OG MATHEM. AFD. I. 2



KOBENHAVN

BIANCO LUNOS BOGTRYKKERI

1901

Søger man i Literaturen Oplysning om, hvorledes Forbindelsen mellem Muskler og Chitinskelet hos Arthropoderne forholder sig i histologisk Henseende, vil man snart faa det Indtryk, at dette Spørgsmaal næppe kan siges at være fuldt løst eller i det hele har været særlig indgaaende behandlet. Mangt og meget desangaaende er kun korte, næsten tilfældige Bemærkninger, spredte i Afhandlinger om ganske andre Æmner; endelig modsige Angivelserne delvis hinanden. Det vil derfor forhaabentlig ikke synes overflødigt at underkaste denne Sag en nøjere Undersøgelse; som Indledning hertil vil jeg forsøge, ved en Sammenstilling af den vigtigste Literatur, at give et Begreb om, hvorledes man til forskellige Tider har forstaaet disse Bygningsforhold.

Den første Forfatter, hos hvem vi træffe Musklernes Befæstningsmaade omtalt, er REICHERT²⁵⁾, der har undersøgt „den penselformede Kæbemuskel“ hos Flodkrebse (*Astacus fluviatilis* L.) og skænker saavel dens ventrale, som dens dorsale Insertion en indgaaende Omtale. Selve Originalafhandlingen var mig desværre ikke tilgængelig; som Erstatning derfor kan jeg heldigvis citere REICHERTS eget Referat i Archiv f. Anatomie, Physiologie etc. „Den continuirlichen Uebergang der Scheide des primitiven Muskelbündels in gewöhnliches Bindegewebe konnte mit grösster Genauigkeit und übersichtlich an den pinselförmigen Kiefermuskel des Flusskrebses beobachtet werden. Die primitive Scheide der Muskelfasern (primitive Muskelbündel) geht hier durchaus continuirlich in die durch ihre grössere Härte und an der Verbindungsstelle gleichfalls noch streifenlose feine Sehnenfaser über, an welchen die Muskelbündel wie Eicheln an ihren Stengeln hängen. Die Sehne wird darauf bald dunkel gestreift, verliert dann wieder die Streifung und setzt sich continuirlich in die Substanz des Kiefers fort. Um zu erfahren, wie sich die primitive Muskelscheide an der scheinbar unmittelbaren Befestigung des Muskels an das Rückenschild verhalte, wurde aus dieser Gegend so feine Durchschnitte gemacht, dass wo möglich nur einzelne primitive Muskelbündel mit der Durchschnittslamelle des Rückenschildes in Verbindung zur mikroskopischen Untersuchung verwendet werden konnten. Hier zeigt sich, dass die primitive Scheide über dem, wie durch einen Querschnitt abgeschnittenen Ende des primitiven Muskelbündels sich schliessend, continuirlich in das weiche Bindegewebe an der Innenfläche des Rückenschildes sich fortsetzt. Das primitive Muskelbündel liegt also frei in einem

cylinderförmig gestaltetem Sacke von Bindesubstanz (primitive Scheide); seine Befestigung mit der Sehne und mit Hartgebilden, desgleichen seine Wirkung bei der Contraction auf die zu bewegendenden Theile geschieht nicht unmittelbar, sondern durch Vermittelung seiner aus Bindesubstanz bestehenden primitiven Scheide“.

Den her udtalte Anskuelse tiltrædes fuldt af LEYDIG¹⁷⁾ og findes ogsaa fremstillet i dennes berømte Histologi¹⁸⁾. Til det af REICHERT givne Eksempel føjes her en Del andre (Hovedmuskler af den røde Myre, Hvepser, Edderkopper o. s. v.), der alle vise, hvorledes Senerne, der maa opfattes som en chitiniseret Bindesubstans, henimod Musklerne forme sig som cylindriske Sække, der omslutte den tværsribede Masse og danne Sarcolemmaet. Om andre Muskler, saaledes alle Kroppens, angives derimod, at de fæste sig paa Hudskelettets Inderflade; Meningene hermed er dog sikkert kun at betone, at der her ikke findes særegne Senebannelser, og ingenlunde, at den egentlige kontraktile Muskelsubstans skulde fæste sig direkte paa Chitinen. At der ikke omtales et „Bindevævslag“, svarende til det allerede af REICHERT fra Kindbakkemuskulens dorsale Fæste nævnte, har utvivlsomt sin Grund i, at dette Lag ikke ansaas for i nogen væsentlig Grad at staa i Modsætning til Sarcolemmaet, snarere vel opfattedes som repræsenterende dette paa nævnte Steder.

I Modsætning hertil fremhæver nu HAECKEL⁹⁾ med Rette Betydningen af den under Chitinen liggende „Chitinogenmembran“ og betoner navnlig dennes Nødvendighed for Skalskiftet; han venter derfor a priori at træffe en saadan alle Steder og finder, at den af REICHERT paastaaede, kontinuerlige Overgang af Senebindevævet i det ydre Chitinpanser „i al Fald de fleste Steder“ let lader sig afvise. Dette gælder f. Eks. angaaende Befæstningen af „Krebsens penselformede Kæbemuskel“ til Rygskjoldet. Her ligger nemlig under Panseret Chitinogenmembranen og først til det underliggende „Cutislag“ fæste „Muskulernes Sener“ sig og tabe sig i dette. Muskulernes Fæste sker efter HAECKEL stadig ved Bindevæv, der dog kan være af højst forskellig Natur, snart løst, blødt og homogent, snart haarde, forkalkede Sener. Tilstedeværelsen af Chitinogenmembranen lykkedes det, som nævnt, vel HAECKEL at paavise mange Steder mellem „Muskelsene“ og Chitinpanser, men dog ikke allevegne, saaledes øjensynligt ikke tilfredsstillende ved Kæbemuskulens ventrale Fæste.

Den fulde Forstaaelse af dette Forhold og navnlig den rette Opfattelse af de chitinagtige Sener, uden hvilken det hele Spørgsmaal næppe lod sig løse, skulde det saaledes først lykkes BAUR¹⁾ at naa. Denne Forfatter paaviser i det nævnte, mønsterværdige Arbejde, hvorledes under Hudsiftet den penselformet forgrenede Chitinsene afstødes i Sammenhæng med Kindbakkens Chitinbeklædning, medens samtidig en ny, endnu blød Sene ligger uden om den gamle og staar i Forbindelse med Kindbakkens nye Skelet. Som Følge heraf slutter han, at Senen rimeligvis maa være dannet ligesom det øvrige Hudskelet og være omgivet af ganske de samme Cellelag som dette. Den mikroskopiske Undersøgelse viser det fuldt be- rettigede i denne Antagelse, thi overalt, ikke blot over Senens Hovedstamme, men

over alle dens talrige Forgreninger ses stadig de samme to Lag overtrækkende Chitinen: inderst det chitindannende Lag i Skikkelse af et kontinuerligt, epithelagtigt Lag af Kerner og „molekular Mellemmasse“ og uden om dette et bindevævsagtigt Hylster; sidstnævnte gaar, hvor Muskelsubstansen begynder, og hvor Chitinen og det chitindannende Lag ophøre, over i „Muskelparenchymets Bindesubstans“; den LEYDIG'ske Beskrivelse af Senens Forhold til Musklen maa derfor ændres til, at det af en Senes tre Lag er det ydre, bindevævsagtige, der henimod Musklen udvider sig tragtformigt, omslutter den tværsribede Muskelecylinder og danner dennes Sarcolemma. Forfatteren fremhæver endelig, hvorledes Chitinsen som Følge af sin ejendommelige Dannelsesmaade naturligvis oprindelig maa være hul og først senere lægger sig sammen til en solid Stav, idet før sidste Hudskifte den ældre Sene laa inden i den nye, en Paastand, hvis Rigtighed Tværsnit tydeligt nok godtgøre.

De næste Angivelser, vi træffe paa angaaende det foreliggende Æmne, findes hos WEISMANN³⁶); de vedrøre Senernes og Musklernes Udvikling og ere vundne ved Undersøgelse af Lemmernes Udvikling hos forskellige Insekter (*Stratiomys*, *Chironomus* og *Pieris*). Det fremgaar saavel af Beskrivelse som af Tegninger, at Anlæg til Muskler og Sener allerede tidlig træde skarpt frem i Modsætning til hverandre: om Musklerne angives, at de paa den ene Side have Rodfæste i den Cellemasse, der udgør største Parten af Leddet (hvilket vist navnlig vil sige Hypodermiscellerne), paa den anden Side derimod i den Cellemasse, der udgør Anlægget til Senen. Af dennes Morphologi tror jeg nu ganske vist ikke, at Weismann har haft en saa klar Opfattelse som BAUR, men, hvad der i denne Sammenhæng er af mest Betydning, dens Opbygning af en „chitiniserende Akse“ omgivet af et kærneholdigt „bindevævsagtigt Overtræk“, hvortil Musklerne fæste sig, har han i al Fald set aldeles rigtigt. Om Sarcolemmaet angives, at det intet som helst har med Senen at gøre; der er slet ikke Kontinuitet mellem disse Dannelser.

Af de følgende Forfattere staar WAGENER³⁴) endnu paa det gamle REICHERT'ske Standpunkt og mener i Laarmusklerne hos Edderkopperne at have fundet et Objekt, der smukt viser Overgangen mellem Muskelskeder og chitiniserende Sener.

En nøjere Beskrivelse af Hypodermiscellerne udfor Musklernes Befæstningspunkter træffes hos BRAUN³). Han angiver, at hos Flodkrebsen undergaar Chitinogenvævet paa saadanne Steder en særlig Omdannelse: man finder her lange, smalle Cylinderceller, hvis mod Panseret rettede Ende viser sig noget opsvulmet og i Besiddelse af en tydelig Længdestribning; hver Celle bærer sin elliptiske, regelmæssige Kerne og er skarpt afgrænset mod Muskeltraadene; paa hver enkelt saadan komme omtrent 7—8 Hypodermisceller. De samme Forhold genfindes i Fordøjelseskanaalen, f. Eks. i Mavens Tænder.

Lignende Angivelser, vedrørende Muskelfæster saavel til Skjoldet som til Oesophagus hos forskellige dekapode Crustaceer, findes hos VITZOU³³); om nogen Stribning i Cellerne, paa hvis Basalmembran Musklerne inserere sig, er her dog ej Tale.

Vi finde dernæst hos LEYDIG¹⁹⁾ en Fremstilling af, hvorledes den nøjere Forbindelse mellem Hypodermisceller og Muskeltraade kommer til Veje. Ved Undersøgelse af en i Sprit opbevaret Larve af en *Hydrophilus* viste det sig, at Muskelskivernes Substans udadtil trevler sig op i fine Fryndser; disse fortsætte sig over i det indadtil ligeledes optrevlede Svampvæv af Protoplasmaet i Integumentets Matrixceller. Denne Beskrivelse, der dog paa Grund af Materialets Opbevaringstilstand næppe paa Forhaand kan gøre Fordring paa ubetinget Tiltro, passer, som man ser, godt med Forestillingen om Cellesubstansens netformede Bygning, hvilken LEYDIG, som bekendt, overalt i den nævnte Bog søger at gennemføre.

Særlig godt skal, efter BERTKAU²⁾, Edderkoppernes Sugemave egne sig til at vise Forholdet mellem Chitin, Hypodermis og Muskler. Der, hvor Muskler fæste sig til Epithelcellerne, skriver han, have af disse alene Kernerne holdt sig uforandrede, medens Celleplasmaet er bleven traadet og gaar over i Muskeltraadene; dog er det for det meste endnu muligt at se Grænsen mellem Epithelcellens og Muskelcellens Traaddel. Den ledsagende Figur viser da ogsaa et kubisk Epithel, der ved en tydelig Linie er skilt fra Muskulaturen.

Om den Maade, hvorpaa hos forskellige dekapode Krebs Muskelinsertionen til Tarmvæggen linder Sted, ere en Del Oplysninger givne i en Afhandling af FRENZEL⁸⁾. Forholdene ere ojetsynlig noget forskelligartede efter de enkelte Former; medens nemlig i Endetarmen af *Maja* og *Paguristes* Epithelcellerne staa tæt ved hinandens Side, ere de hos andre, saasom *Astacus* og end mere hos *Scyllarus*, skilte enten enkeltvis eller i Grupper af traadete Muskelsener, der fæste sig til Cuticula. Forfatteren er ikke ganske sikker paa, om disse Sener ere chitinøse og saaledes at anse for en Dannelse fra Matrixcellerne, eller om det er bindevævsagtige Strænge, der skyde sig ind mellem disse Celler. Det sidste forekommer ham dog at være det sandsynligste, thi for det første farve de sig livligt røde med Karmin, hvad derimod de chitinøse Dannelser ikke gøre, og desuden gaa de delvis direkte over i det cellet-traadete Bindevæv i Længdefoldernes Indre. Navnlig hos *Scyllarus* ere disse Senetraade rigelig til Stede „und hier und da nehmen sie fast die ganze Breite einer Epithelzelle ein um sich nach oben hin in Form eines Dreiecks unter mannichfachen Verästeln noch mehr zu verbreiten auf welcher Weise eine möglichst grosse Ansatzfläche an der Basis der Cuticula gewonnen wird“. Undertiden kan man se Muskelstammer træde nær hen^{*)} til Cuticula, som hos *Astacus* og *Scyllarus*, men i Reglen fæste disse sig først ved Basis af Epithelet til deres Sener i Form af fine Fibriller, der lidt efter lidt paa deres Vej ud imod Periferien forene sig med andre og paa den Maade danne kraftige Muskelstammer.

Vende vi os derpaa til en anden Orden af Krebsdyrene, til Phylloporerne, finde vi hos CLAUS⁴⁾ en Fremstilling givet af Forholdene hos *Branchipus*. De subcuticulære Matrixceller ere her overordentlig vekslende, saavel i Størrelse som i Form; de vise paa mange Steder, navnlig hvor Muskler hæfte sig til dem, en ud-

*) Paa en Figur af *Astacus* ses Musklerne endog gaaende helt ud til Chitinen!

præget Tendens til Omdannelse af Protoplasmaet til fastere, stribet Substans, henholdsvis til skraat nedstigende Traadbundter, der vinde Betydning af bindevævsagtige Sener og danne Musklerne Befæstning til Chitinen. Foruden Kernen, der ligger tæt op til det til Traadsubstans omdannede Plasma, bevarer en Del af Cellelegemet sin bløde Beskaffenhed og fremtræder som et netformet Væv, der i Forening med Kernerne opfylder Mellemrummene mellem de hærdede Traadbundter. Ganske samme Struktur vise Hypodermiseellerne ogsaa paa de Steder, hvor Musklerne ikke fæste sig direkte til disse, men derimod til det ejendommelige Lag, „der som en Art indre Cuticula er opstaaet ved Basis af Epithelet ved Hærdning af Protoplasmaet“. Dette Lag opfattes saaledes i Hovedsagen som en mægtigt udviklet Basalmembran, dannet ved en Art „indre Chitinisering“ af Matrixcellerne; paa visse Steder, hvor det fortykkes til en, ligesom ved Lagdeling stribet Seneplade, tør det alligevel anses for ret rimeligt, at ogsaa visse Bindevævs-elementer have Del i dets Dannelse. Med Chitinen staar denne Basalmembran, hvortil som nævnt Musklerne ofte inserere sig, i Forbindelse ved Hjælp af de traadede Matrixceller, der som Støttepiller forene de to Lag; paa saadanne Steder skal der ofte være Mellemrum mellem de enkelte Matrixceller; de tydes som Blodrum, erindrende om de interstitielle Lymferum i Bindevævet. I det hele synes CLAUS tilbøjelig til at opfatte Hypodermis som et Bindevæv, i hvilket efter hans Mening den ydre Chitinbeklædning, Støtteetraadene i Matrixcellerne samt Basalmembranen ere fremkomne som i alt væsentligt ligeartede Omdannelser af vedkommende Cellers Protoplasma; dog erkendte han selv, at der i kemisk Henseende var en Forskel paa Chitinen i Modsætning til de andre Dannelser, der f. Eks. farves røde af Karmin. Dette Forsøg paa saaledes at genoplive REICHERT's og LEYDIG's gamle Anskuelse vandt dog ingen Tilslutning; skarpt kritiseret er det f. Eks. blevet af MAYER²²⁾.

I en Afhandling af WAGNER²³⁾ om Hudskiftet hos Edderkopperne nævnes følgende Arter af Muskelinsertion: 1) den direkte, 2) den indirekte ved Sener. Om Forholdene ved Hudskiftet berettes, at hvor der findes Sener, vokser Matrix før Hudskiftet op ad disse op til selve Musklen og udskiller den nye Sene; efter at denne er dannet, og den gamle er trukken ud, angives Matrix om Senen igen fuldstændig at forsvinde. Der hvor Musklerne med bred Basis fæste sig til Huden, afkastes sammen med Chitinen ogsaa den nærliggende Ende af hver Muskelskede, der er dannet af det subcutane Bindevæv; efter sin Nydannelse træder den først langsomt igen i Forbindelse med Sarcolemmaet. Jeg tilstaar gerne, at adskilligt heraf er mig komplet uforstaaeligt.

Med stor Sikkerhed udtaler ANTON SCHNEIDER²⁴⁾ som en for Arthropoderne almengyldig Regel, at hvor Muskeltraade fæste sig til Kropvæggen, gaa Fibrillerne gennem Protoplasmaet hen til Chitinen, medens samtidig Hypodermis' skarpt begrænsede indre Grænselag slaar sig over paa Fibrilbundtet og danner et Sarcolemma over dette; der bestaar saaledes ikke nogen Adskillelse mellem Muskeltraad

og Hypodermis. Derved ledes Forfatteren endog til at tvivle om det berettigede i at tale om et Ektoderm og et Mesoderm og mener, at man i Stedet derfor burde indføre Betegnelsen Ekto-Mesodermet. Om Chitindannelsen, der antages at foregaa ved „eine Erhärtung des Protoplasma“, anføres, at saavel Hypodermis som Muskler deltage deri. Den derved frembragte Chitin er væsentlig ens, kun er af og til „Muskelchitinen“ haardere og tykkere end „Protoplasmachitinen“.

I Fordøjelseskanaalen hos de hedriophthalme Krebs skal Lø¹²⁾ have paavist Muskler, der fæste sig direkte paa Chitinen; omtalte Arbejde kender jeg desværre kun af ganske korte Citater¹⁾.

Det samme gælder en Afhandling af SADONES²⁷⁾, hvori det om Musklerne i Kroen hos Larven til *Libellula depressa* L. angives, at de skyde Epithelcellerne til Side og med „noget chitiniserede“ Ender fæste sig direkte paa Chitinen.

Dernæst beskriver LISR²⁰⁾ hos forskellige dekapode Krebs, f. Eks. *Palaemon serratus* F., hvorledes Musklerne, efter først at have mistet deres Tværstribning og i Stedet derfor at have antaget en ejendommelig, trævlet Struktur, fæste sig til Hypodermiscellerne. Med Hensyn til Senernes Dannelse fremstilles, hvorledes man kan finde den senere chitinøse Substans liggende, i Skikkelse af et Maskeværk, omgivet af et kerneholdigt Protoplasma; Muskulaturen støder direkte op til disse Dannelsesceller.

For Tusindbenenes Vedkommende kan man ogsaa i Henseende til Muskel-fæster finde værdifulde Oplysninger hos DUBOSQ⁷⁾. Arthropodernes Sener beskrives her som Indkrængninger af Huden, „ganske som en Kirtel eller en Traché“; de ere hule i Midten og dannes af et Epithellag, hvis Cytoplasma imidlertid er af en saa fibrillær Bygning, at det derved kan mistydes. Ogsaa hvor Musklerne inserere sig direkte paa Hudskelettets Overflade, ser man under Chitinen en Række Epithelceller med stærkt fibrillært Cytoplasma. Det er ægte Seneceller; deres Kerner ligge klemte op til den fibrillære Del eller inde i samme, aldrig derimod i de klare Mellemrum mellem Fibrilmasserne; disse Rum tydes som Intercellulærrum. Der findes ingen Basalmembran som Grænse mellem Senecelle og Muskel; ofte ser man derimod, hvorledes den ellers tilstedeværende Basalmembran bøjer sig tilbage for at blive Muskels Sarclemma; saaledes ligger Muskeltraaden, sammen med Epithelcellerne, omsluttet af Basalmembranen. Imidlertid kan der vise sig en mørk Grænselinie mellem Epithelcelle og Muskel, men dette hidrører kun fra en Række Fortykkelser paa Fibrillerne; om de høre Epithelcellernes eller Muskels Fibriller til, lader sig ej afgøre, da disse ikke kan skelnes fra hinanden; af og til kan disse Fortykkelser smelte sammen og gøre Indtryk af at være en Basalmembran, men det er ikke Regelen. Musklerne tabe, for de træde i Forbindelse med Epithelet, deres Tværstribning; der dannes saaledes et Bælte af rent

¹⁾ Senere Tilføjelse. Herefter burde været omtalt en Afhandling af JANET¹³⁾, men dels var denne mig utilgængelig, dels kunde jeg efter det (desværre altfor kortfattede) Referat, som findes i „Zoologischer Jahresbericht, 1895“, heller ikke vente at finde noget af Interesse deri.

seneagtige Traade; dette kan snart være meget langt, snart forsvindende kort, men er altid til Stede. Som en Støtte for denne Antagelse af en Forbindelse mellem Epidermis- og Muskelceller henviser DUBOSCQ endelig til, at HEATHCOTE hos unge Stadier af *Julus* har paavist stærke Anastomoser mellem Ektodermets og Mesodermets Celler.

Som Talsmand for en ganske anden Opfattelse staar derimod PANTEL²⁴⁾, der efter Undersøgelse af den parasitiske Larve til Fluen *Thrixion Halidayanum* Rond. mener at kunne fastslaa, at Musklerne hos denne Form absolut ikke fæste sig til Hypodermiscellerne, men derimod direkte paa Chitinen. Den kontraktile Stræng gaar helt ud til Cuticula og smelter solidt fast dertil ved Hjælp af et særlig omdannet Lag, der physiologisk tjener som en Sene. Denne Insertionsmaade, som man genfinder hos Crustaceerne (PANTEL har selv konstateret det hos de terrestriske Isopoder og henviser desuden til IDE's Arbejde over Hedriophthalmernes Tarm), hindrer dog ingenlunde Cuticula fra at løsne sig som Helhed under Hudskeftet, endog udfor Muskeltraadenes Ender, hvad Forfatteren selv har kunnet iagttage. Dog viser det sig ved samme Lejlighed, at Forbindelsen med Chitinen paa saadanne Steder er inderligere end andetsteds, „hvad der ikke vilde være Tilfældet, hvis der kun var en Hypodermiscelle at løsne“.

Om Musklerne i Svalget af *Oniscus* og *Asellus* angiver derpaa SCHÖNICHEN³⁰⁾, at disse, efter at have opløst sig i deres Primitivfibriller, gennembryde Epithelet og fæste sig paa dettes Intima; de vise samtidig tydeligt deres Tværstribning lige til deres Befæstelsespunkt.

Til et lignende Resultat som PANTEL kommer HECHT¹⁰⁾ i sin Monografi af den ejendommelige Larve til Fluen *Microdon mutabilis* L. Her beskrives, hvorledes Musklerne i Stedet for at fæste sig til Epithelcellernes Basis derimod strække sig ind langs med disses Sider, hvor de tydeligt nok fremtræde mod de tilgrænsende Epithelceller. Muskeltraaden bliver paa sin Vej henimod Chitinen tyndere og tyndere; efter at være naaet hen til denne gaar den over i denne og breder sig paany til en kegleformet Dannelse, der først ender ude ved den paa saadanne Steder noget fordybede Overflade. Ofte iagttages i denne i Chitinen liggende Kegel en Længdestribning, der er mere eller mindre fremtrædende alt efter Chitinens mere eller mindre tydelige Sammensætning af med Overfladen parallelle Lameller; stundom danne disse to Stribesystemer et tavlet Mønster.

Lad os dernæst betragte de Angivelser, der for nylig ere fremførte af N. HOLMGREN¹¹⁾ og vundne ved Undersøgelse af forskellige Fluer. Tre Arter af Muskelefæster beskrives her som forekommende ved hinandens Side saa godt som i hvert Snit gennem Skeden af *Sarcophaga carnaria* L. I første Tilfælde fortrænger Muskelellen Chitinens Matrixceller for at faa et frit Insertionssted, mister derpaa sin Tværstribning og opløser sig i sine enkelte Fibriller, som med deres chitiniserede, distale Ende trænge ind i Chitinen. I det andet Tilfælde, der skal svare til Angivelserne hos FRENZEL og IDE, brede Muskelcellerne sig, efter at have mistet

deres Tværstrikning, nd i et Antal Grene, der bestaa af et tyndt Sarcoglialeg og Muskelfibriller; disse Grene omspinde Epithelierne og strække sig hen imod Chitinlaget, hvor de opløse sig i deres Primitivfibriller, der chitinisere og trænge ind i Chitinen. Den tredje Insertionsmaade betragtes som ganske identisk med den, som LEYDIG og DUBOSCQ have beskrevet; dog ser Forf. her ikke en Forening af epitheliale og muskulære Fibriller, men mener, at det er Muskelcellens Fibriller, der trænge igennem Epithelcellen for endelig med en chitiniseret Del at fæste sig i Chitinen.

Endelig maa jeg omtale et Par Bidrag til Belysning af det foreliggende Spørgsmaal, der imidlertid først ere blevne mig bekendte, da jeg stod i Færd med at afslutte min egen Undersøgelse.

DE SINÉTY³¹⁾ angiver, at hos *Periplaneta Australasie* F. fæste Musklerne sig til Epidermisceller, hvis Struktur er betydelig forandret, idet deres Protoplasma danner „et langmasket Net, der godt kunde tages for Fibriller“; hos en Phasmide (*Leptynia attenuata* Pant.) bryde derimod Musklernes seneagtige Ende sig Vej gennem Epithelet.

I sin Beskrivelse af Muskelfæster hos *Nebalia* omtaler LABBÉ¹⁶⁾ saavel Epithelet med dets seneagtige Fibriller „Tonofibrilles“ som Muskulens Afslutning ved Epithelets Grænse med en tynd, mørk Skive; Muskulens og Epithelets Fibriller antages at ligge i hinandens Forlængelse, adskilte ved en af de tynde, mørke Skiver dannet Basalmembran.

Stor Interesse har den af skematiske Figurer ledsagede Fremstilling, hvori JANET¹⁴⁾ viser sin Opfattelse af Variationerne af de hypodermale Insertionsceller hos forskellige Hymenopterer. I mange Tilfælde indskrænker Omdannelsen af Epithelcellerne sig til, at der i disse optræde rækkestillede Chitinpartikler, der smelte sammen til Traade; disse strække sig gennem Cellens hele Dybde og fæste sig til det først dannede, ydre Chitinlag; senere indstøbes deres distale Ender i de dybere liggende, yngre Lag af Chitinen. I andre Tilfælde kan derimod Epithelcellerne med deres chitinøse „fibrilles de résistance“ tiltage mere eller mindre i Længde indefter, idet samtidig deres distale Ende omdannes til en tynd Stilk, medens den proximale Del tiltager i Omfang og udhules til en Skaal, der omfatter den afrundede Ende af et Muskelbundt; de chitinøse Støttestraade kunne snart holde sig uafhængige indbyrdes, snart smelte sammen. Disse saa ejendommeligt uddannede, stærkt forlængede og i deres Indre chitiniserede Epithelceller synes kun at findes hos Imagines, hvor deres Eksistens allerede tidligere er paavist i et Arbejde *) af samme Forfatter¹³⁾. I dette er Opfattelsen af Forholdene dog en ganske anden, idet de mere eller mindre forlængede, proximale udhulede, epitheliale Sener beskrives som Endegrene af de chitiniserede Apodemata, og saavel her som andetsteds Muskelinsertionen betegnes som direkte.

Den hermed tilendebragte Sammenstilling viser tydeligt, hvorledes der til

*) Jeg er Museumsinspektør, Dr. MEINERT, megen Tak skyldig, saavel fordi han laante mig dette Arbejde som for hans velvillige Hjælp ved Bestemmelsen af visse af de benyttede Dyr.

Stadighed mod hinanden staa to*) aldeles forskellige Opfattelser af Muskelfæsternes Art, idet en Gruppe Forfattere, blandt hvilke jeg vil fremhæve HAECKEL, BAUR, BRAUN, LEYDIG, BERTKAU, JANET og DUBOSCQ (samt tildels HOLMGREN), hævde Tilstedeværelsen af et mellem Chitin og Muskel liggende Epithel, hvis fibrillære Bygning alt er paavist af BRAUN og BERTKAU. I Modsætning hertil staa (foruden visse ældre Forfattere, hvem Chitinsensens Bygning var ukendt) ANT. SCHNEIDER, IDE, SADONES, PANTEL, SCHÖNICHEN og HECHT (samt tildels HOLMGREN), der anse Musklerne for at fæste sig direkte til Chitinen; herved maa dog mærkes, at Muskulens distale Ende i saa Fald næsten stedse (af alle Forfattere undtagen SCHÖNICHEN) angives at have mistet sin karakteristiske Tværstribning og i Stedet derfor skal vise sig seneagtig, kun sammensat af Længdefibriller.

Førend jeg nu i det følgende gaar over til at undersøge Repræsentanter af de forskellige Leddyrgrupper, vil jeg forudskikke nogle faa, tekniske Bemærkninger. Til Fiksering har jeg med størst Held benyttet kogende Vand, kogende Alkohol samt Formol-Sublimat; efter omhyggelig Afvanding i Alkohol af stigende Procentindhold førtes Stykkerne derpaa gennem Toluol over i „filtreret Paraffin, GRÜBLER“, af hvilken jeg benyttede den ved 58° C. smeltende Sort enten ren eller blandet med en mindre Del af en mere letsmeltelig; heri lykkes det som Regel at skære Dyr, selv med ret tyk Chitin, i fejlfrie Serier af tynde Snit. Til Opklæbningen af disse, hvis Tykkelse vekslede mellem 5 og 10 μ , brugtes (efter MAYER) Vand og et Spor af Æggehvite-Glycerin; det er af største Vigtighed, at Snittene blive fuldstændig glattede ud, idet ellers senere Chitinen river sig løs. Til Farvning har jeg navnlig benyttet MAYER's Hæmallun i Forbindelse med en Plasmafärbning med Orange G (i 2% Allunopløsning), hvorved man i Regelen kan faa en smuk Farvemodsætning frem mellem Hypodermis og Muskulaturen. Til Paavisning af muligt tilstedeværende Bindevæv, af Basalmembraner eller lignende lader, efter Kernefarvning med Hæmallun, HANSEN's Syrefuchsin-Pikrinsyre eller Syrefuchsin alene sig udmærket anvende. Præparaterne ere endelig indlagte i Kanadabalsam.

Herefter vil jeg gaa over til de specielle Undersøgelser og til en Begyndelse betragte Forholdene hos

Insekterne.

Jeg vil her gennemgaa i systematisk Rækkefølge de forskellige Ordener, idet jeg begynder med en af de mest primitive**) Former, med Sølvkræet (*Lepisma saccharinum* L.) af Apterernes Orden. Et smukt Muskelfæste viser sig her paa

*) Den tredje Gruppe, som HOLMGREN foreslaar for visse af FRENZEL, IDE og ham selv beskrevne Insertioner, synes mig langt fra tilstrækkelig begrundet; det forekommer mig paa Forhaand langt naturligere at lade ogsaa disse Tilfælde gaa ind under den direkte Insertionsmodus.

**) Det er maaske ikke overflodigt straks at bemærke, at der selvfølgelig ikke er nogen Grund til at antage, at Muskler og Muskelfæster skulde staa paa et særlig primitivt Standpunkt hos iøvrigt

Baghovedets Overflade (Fig. 1), hvor en hel Gruppe smalle Muskelbundter inserere sig. Disse vise, foruden deres Sammensætning af Længdefibriller, en tydelig Tværstribning; store Kerner ses i dem, liggende tæt under Sarcolemmaet, der flere Steder blæreformet har løsnet sig fra den contractile Substans. Denne naar ikke helt ud til Chitinen, men skilles derfra ved et eget, ganske anderledes farvet, fibrillært Lag, der er af samme Højde som Hypodermiscellerne og tydeligt nok, hvad der fremgaar af Tilstedeværelsen af Kerner, ogsaa kun kan opfattes som bestaaende af saadanne. Til at vise Forskellen mellem de omdannede Celler, hvortil Muskler fæste sig, og de øvrige uforandrede er dette Præparat særlig instruktivt; overalt har udfor Musklerne Protoplasmaet uddannet fine, men tydelige Fibriller, der gore disse Cellepartier stærkt fremtrædende i Modsætning til de mellemliggende. Basalmembranen, der udfor de uomdannede Partier er saa let at iagttage, er derimod mellem Musklen og de fibrillære „Seneceller“ næsten ikke til at se; at den dog er tilstede forekommer mig at være det sandsynligste, saasom jeg i Muskelfæster andetsteds (f. Eks. til Bugskinnen af første Bagkropsring) med største Tydelighed har kunnet konstatere dens Eksistens.

Den følgende Afbildning (Fig. 2) viser et Eksempel paa, hvor overordentlig lave Hypodermiscellerne stundom kunne blive; den fremstiller et Muskelfæste i tredje Benpar. Cellerne danne her et saa tyndt Lag, at Kernerne for at faa Plads ere blevne ganske fladtrykte; alligevel fremtræder Laget aldeles tydeligt imod Muskulaturen og synes ogsaa at vise den sædvanlige, fibrillære Bygning.

For Fuldstændigheds Skyld nævner jeg endelig, at ogsaa alle de fra det ydre Skelet udspringende „Sener“ (Apodemata) i Henseende til Muskelinsertioner forholde sig ganske som dette.

I de hidtil omtalte Figurer findes ganske vist Kerner i det antagne Epithel udfor Musklerne, men deres Antal kan stundom være saa ringe, at man, i al Fald ved en Betragtning af Figurerne alene, kunde tænke sig den Mulighed, at Musklen skød Epithelecellerne til Side og med en særegent omdannet Ende fæstede sig paa Chitinen; de Kerner, der ere afbildede i Fibrilmassen, skulde efter den Antagelse kun tilsyneladende ligge inde i denne; imidlertid fremgaar det af Seriesnit tydeligt nok, at de virkelig have Plads i Fibrilmassen. Andetsteds ere Kernerne saa talrige, at man af den Grund næppe vil formode en direkte Insertion. Gaa vi saaledes over til Orthoptererne, vil jeg henvise til et Snit (Fig. 3) gennem Rygsiden af Bagkroppen hos en Kakkerlak (*Periplaneta americana* L.); her finder man under Chitinen i det fibrillære Lag et stort Antal Kerner, der saavel i Form og Størrelse, som ogsaa i Struktur staa i Modsætning til Muskelkernerne. En tydelig Basalmembran danner her en Grænse mellem Epithetet og Muskulaturen, der, ligesom

primitive Former. Den højere eller lavere Udvikling af disse Dele er øjensynlig betinget af ganske andre Forhold, nemlig hvorvidt det omtalte Dyr er særlig uddannet til hurtig Bevægelse eller ej; dette viser sig tydeligt nok i Musklernes Tværstribning, idet de i den Henseende ejendommeligst uddannede Muskler netop ere bestemte til særlig energisk Virksomhed, f. Eks. ere Vingemuskler.

i andre Tilfælde, hvor Tværstribningen er vel udpræget, ses at ende med Halvdelen af en lys, isotrop Skive.

I et Muskelfæste (Fig. 4) sammesteds fra, men af et ganske forskelligt Udseende, ses smukt Modsætningen mellem de uomdannede Hypodermisceller med deres netformet-kornede Protoplasma og de hypodermale Seneceller, hvis mere ensartet udseende Protoplasma ved nøjere Betragtning viser en ikke særlig fremtrædende Længdestribning. Der findes her, i Modsætning til i de før omtalte Tilfælde, en vis Adskillelse mellem de enkelte Seneceller, idet hele Muskelfæstets Epithelmasse viser sig som delt i en Række tæstillede, smalle Protoplasmapiller, der hver bærer en langstrakt Kerne trykket tæt op til sig og med sin distale Ende ligger lidt indsenket i Chitinen; alt dette ses dog endnu bedre af den følgende Afbildning (Fig. 5), der stammer fra det centrale Parti af samme Muskelfæste. Basalmembranens Forhold er meget ejendommeligt (Fig. 4): udfor de uomdannede Celler viser den sig endog ganske ualmindeligt fremtrædende for dernæst ved Muskens Begyndelse pludselig at blive utydelig*). Alligevel er det ikke svært at se, hvor Musklen hører op, og hvor Epithelet begynder, og det uagtet Grænsen mellem de to Elementer ikke er en ret Linie, men tværtimod ofte de enkelte Muskelbundter ligge ligesom indplantede i Epithelmassen. I de hidtil omtalte Præparater af *Periplaneta* have Hypodermiscellerne udmærket sig ved deres anselige Størrelse; andetsteds, f. Eks. i Hovedet, findes imidlertid Steder med ganske fladtrykte, hypodermale Seneceller.

Tilslidst ville vi kaste et Blik paa et Snit gennem samme Dyrs Bagtarm (Fig. 6). Denne er dannet af et Lag mod hinanden vel afgrænsede Celler, der indad have udskilt et ujævnt Chitinlag. Udadtil overtrækkes Epithelet af fine, tværstribede Muskeltraade; enkelte af disse (Dilatatorer) kan man se fæste sig til Tarmvæggens Epithelceller. En saadan Muskeltraad er meget smallere end Epithelcellen, den fæster sig paa; denne er heller ikke særlig omdannet, idet det eneste særegne, man iagttager i den, er, at det traadet-netformede Protoplasma ligesom samler sig noget henimod Muskens Befæstelsespunkt. Da jeg har haft Seriesnit for mig, er jeg vis paa, at Musklen ikke løber ind imellem Cellerne; at der i det afbildede Snit ikke ligger nogen Kerne i Cellen udfor Muskeltraaden skyldes den Omstændighed, at Cellen er lidt tangentialt truffen; den tilhørende Kerne ses derimod i det følgende Snit.

Af andre Orthopterer**) har jeg undersøgt Ørentvisten (*Forficula auricularia* L.)

*) Dette stemmer med, hvad MINGAZZINI²³⁾ har angivet for *Periplaneta orientalis* L., nemlig at Basalmembranen mangler udfor Muskelfæsterne; nogen mere omfattende Gyldighed vil denne Sætning dog næppe faa, thi ikke blot mener jeg andetsteds (Fig. 3) hos *Periplaneta americana* at se en, ganske vist fin Basalmembran, men i hvert Fald indenfor andre Insektordener, f. Eks. hos Nymfen af *Agrion*, lader en anselig Basalmembran sig let paavise, ogsaa udfor Musklerne.

**) I et nylig udkommet Arbejde beskriver DE SINEY Muskelfæster hos *Periplaneta Australasie* F. og en Phasmide (*Leptynia attenuata* Pant.). Beskrivelsen og Figuren (loc. cit. Fig. 4) af den første stemmer ret godt med, hvad jeg selv har paavist hos en anden Art (Fig. 4 og 5); kun er næppe Muskens Ende helt nøjagtigt fremstillet, idet dens Tværstribning ophører, før den har naaet Epithelet. Hos

samt en lille Skovgræshoppe (*Meconema varium* F.) uden dog nogetsteds at træffe Bygningsforhold, der kendelig afvege fra de alt beskrevne.

Jeg gaar derefter over til Neuroptererne^{*)}, blandt hvilke jeg begynder med Guldsmedene; de afbildede Snit stamme fra en snart udvoksen Nymfe af en *Agrion*; det første (Fig. 7) viser et Muskelfæste i Hovedet. Under Chitinen, der, efter Farvning med HANSEN's Hæmatoxylin og derefter HANSEN's Syrefuchsin-Pikrinsyre, særlig tydeligt viser sig bestaaende af tre Lag, yderst et tyndt, stærkt gulfarvet, derunder et mørkerødt og inderst et lyserødt, ses dels uomdannede Hypodermisceller, dels udfor Musklerne fibrillære Seneceller. Disse fremtræde i en svagt timeglasformet Skikkelse, som dog muligvis alene har sin Grund i en, selv efter de forskellige Fikseringsmetoder optrædende Skrumpning, og besidde en stor Kerne, der i Modsætning til hos *Periplaneta* (Fig. 5) stedse synes at ligge midt inde i Fibrilbundtet. Indadtil begrænses Epithelet af en aldeles tydelig, rødfarvet Basalmembran; en saadan synes imidlertid andetsteds at være meget tynd, ja næsten at kunne mangle; alligevel vil man ikke af den Grund føle sig fristet til at antage et direkte Fæste af Musklerne paa Chitinen, idet for det første Tværstribningen aldrig naar ud til denne, og dernæst det lige under Chitinen liggende Lag stedse enten ved Kernernes Form og Antal eller ved sin Plasmastruktur og Maade at optage Farve paa staar i tydelig Modsætning til den indenfor liggende tværsribede Muskel. Længdefibriller er meget tydelige baade i Musklerne og i Epithelet; men det er vanskeligt med Sikkerhed at afgøre, hvorvidt de ere kontinuerlige eller kun ligge i hinandens Forlængelse, om end det sidste synes mig at være det sandsynligste.

Hos Nymfer, der, som den her benyttede, ere saa gamle, at de snart skulle skifte Hud for sidste Gang, har man fortræffelig Lejlighed til at studere Muskler og Sener paa tidligere Stadier, idet Vingemuskulaturen da er ved at udvikle sig. En god Oversigt over Forholdene giver et Snit gennem Basis af Nymfens Vinge (Fig. 8). Man genkender let den lagdelte Chitin og under denne Hypodermis, der er usædvanlig cellerig, utvivlsomt fordi den efter det forestaaende Hudskifte vil blive strakt over en langt større Overflade. Den Cellemasse, der forbinder de to Overflader, og som bestaar af lange, fra hinanden vel sondrede Cellerækker, er Anlægget til Musklen. Ved dennes øvre Fæste ser man, hvorledes Hypodermis saa at sige slaar en Fold og samtidig hermed har dannet en Chitintap (af samme Farve som det inderste Lag); øjensynligt have vi her Begyndelsen til et Apodema, der skal danne Fæstet for Musklen ene Ende. De hypodermale Seneceller (loc. cit. Fig. 3) skal Musklen fibrillært omdannede Ende bane sig Vej mellem Epithelcellerne; imidlertid er der efter mit Skøn en saa betydelig Lighed til Stede mellem de to Figurer, at jeg føler mig overtydet om, at de maa kunne forklares paa samme Maade, en Antagelse, der vinder i Sandsynlighed, naar man betragter en anden Figur af *Leptynia* (loc. cit. Fig. 1), hvor Overensstemmelsen med *Periplaneta* er end mere iøjnefaldende.

^{*)} I systematisk Henseende følger jeg D. SHARP: *Insects*. (The Cambridge Natural History, Vol. V, VI; London, 1901.)

celler, der kun ligge i et Lag, ere allerede let kendelige overfor de øvrige Celler i Hypodermis; udfor Apodemaet ere de lange og smalle, af Pladshensyn tilspidsede i deres distale Ende, med hvilken de fæste sig til, eller, paa Grund af det lidt tangentiale Snit, ses at dække lidt af Apodemaets Spids. Saavel her som i det nedre Muskelfæste, hvor Hypodermiscellerne allerede have begyndt at uddanne Fibriller i deres Protoplasma, er det ikke vanskeligt at paapege Grænsen mellem Epithelet og det noget mørkere farvede Muskelanlæg; foroven løber Epithelet i en Trekant lidt ned paa Musklenes ene Side, rimeligvis fordi Snittet der er lidt tangentielt i Forhold til Musklen, forinden ses derimod de enkelte Cellerækker indplantede i Hypodermis. Enkeltheder ses dog først tydeligt i den følgende Afbildning (Fig. 9), der i større Maalestok viser en Del af et andet, langt bredere Muskelanlæg. Støttepunkt for Musklen er her et langt, næsten pladeformigt Apodema, af hvilket en Stump ses i Figuren; den mørke Tegning deri fremstiller de ældste, i Senen altsaa inderste Dele af Chitinen. Op hertil slutter sig dels uomdannet Hypodermis med store runde Kerner, dels en Række palissadeagtige Seneceller med mere langstrakte Kerner. Disse Celler ere ikke ganske lige lange; vel fæste de sig omtrent i samme Højde med afrundede Ender til Chitinen, men med deres modsatte Ender skyde de sig noget ind imellem de ligeledes ulige lange Cellerækker i Muskelanlægget. Hver saadan Række svarer utvivlsomt i den færdige Muskel til et Primitivbundt og er omgivet af sin særlige Hinde, sit Sarcolemma. I den distale Ende afslutte disse Cellerækker svagt tilspidsede; de faa her desuden et vist, ligesom udløst Udseende, idet talrige fine Fibriller i Epithelcellerne løbe hen imod dem og, som det synes, fæste sig til dem. Den Basalmembran eller maaske rettere det fine Bindevævslag, der begrænser det uomdannede Epithel indadtil, strækker sig ogsaa hen over Muskelanlægget; jeg er dog mest tilbøjelig til at tro, at det kun lægger sig tæt hen over Sarcolemmaet.

Der findes, hos SADONES, en Angivelse om direkte Insertion i Kroen af Larven til *Libellula depressa* L.; jeg har desværre ikke faaet undersøgt nævnte Dyr, men da jeg ikke har fundet noget særlig paafaldende sammesteds hos Nymfen af *Agrion*, og der tilmed for *Libellula depressa* er angivet, at Musklernes Ender ere „noget chitiniserede“, er en Undersøgelse vist heller ikke nødvendig, idet den nævnte Beskrivelse efter mit Skøn netop angiver, at der eksisterer et Afsnit af en særegen Beskaffenhed (ø: en epithelial Fibrilmasse) mellem den kontraktile Substans og Chitinen.

Af de øvrige Neuropterer har jeg undersøgt Larverne af *Ephemera* og af *Perlameleon*. Derimod er Phryganidelarver ganske særlig egnede til at vise den Farvedifferentiering, der kan fremkomme ved Farvning med Hæmalaun og Orange, idet Epithelet staar tydeligt blaåt mod den gullige Muskelsubstans. En Basalmembran er snart tydelig, snart næsten ikke til at se. Ejendommeligt er det ringe Antal Kerner, der findes i det epitheliale Seneparti: man kan saaledes i et enkelt Snit

undersøge mange Muskelfæster uden deri at finde saadanne; det afhænger rimeligvis væsentlig deraf, at Kernerne i Huden, i al Fald i den bløde Bagkrop, hvorfra omtalte Snit stamme, i det hele ligge i stor indbyrdes Afstand. Ret ofte og navnlig ved de ganske smalle Muskler synes der overhovedet ikke at findes Kerner inde i Fibrilmassen: derimod ses, tæt op til denne, en enkelt særlig stor Kerne; det ser her ud, som om hele Muskelfæstets Seneparti er uddannet indenfor en enkelt Celles Omraade. At Kernen ligger udenfor Fibrilbundtet fortjener ikke særlig Opmærksomhed, da vi alt tidligere hos *Periplaneta* (Fig. 5) have truffet den med samme Beliggenhed; i de brede Fæster ses desuden Kerner inde i Fibrilmassen.

Et smukt Eksempel paa, hvorledes man ogsaa hos Hymenoptererne træffer det chitinogene Epithel mellem Musklen og Chitinen, har man i et Snit (Fig. 10) gennem Brystet af en Humlebi (*Bombus*). Musklen, hvis Primitivecyindre fremtræde som grove Fibriller med kun lidet iøjnefaldende Tværstribning, indeholder talrige, lange, næsten traadfine Kerner; i Hypodermis udmærke disse sig derimod netop ved deres usædvanlige Størrelse. I mange andre Tilfælde kan imidlertid hos samme Dyr Epithelcellerne være langt uanseligere, men tydelige ere de stedse.

Det i følgende Figur (Fig. 11) fremstillede højst ejendommelige Muskelfæste stammer fra Brystet af samme Dyr; desværre kan jeg ikke sikkert oplyse dets Plads, da min Snitserie paa Grund af den sprøde Chitin er noget mangelfuld. Chitinen, henimod hvilken Musklerne strække sig, er ret tynd og viser sig tildels fra Fladen; dens Yderside er prydet med en i Figuren kun antydnet Skulptur; jeg har Grund til at tro, at den danner Udklædningen af et opsvulmet Parti af Trachésystemet. Paa Chitinens Inderside ses i et tyndt Protoplasmalag store, fladtrykte Kerner; desuden fæste sig til den nogle lange, stærkt fibrillære Dannelser, der hver med deres proximale Ende fæste sig til en Muskeltraad. De bære hver en Kerne, der ofte med stor Tydelighed ses at ligge paa Siden af Fibrilbundtet. Jeg kan ikke tro andet, end at man maa være berettiget til at forklare disse lange Muskelsener som dannede af stærkt forlængede Epithelceller, hvis Protoplasma har undergaaet en fibrillær Omdannelse; de store Kerner, der ligge ved Senernes Basis op til Chitinen, blive derimod at opfatte som hørende til uomdannede Celler indenfor det samme Epithel.

Endelig maa jeg nævne, at jeg (stadig i Brystet hos samme Dyr) har iagttaget visse endnu mere langstrakte Senedannelser, der utvivlsomt maa forklares paa samme Vis; i mine Snit ligge de dog saa uheldigt trufne, at jeg vil foretrække desangaaende at henvise til et senere omtalt Præparat af en Spyflue (Fig. 21), der med største Tydelighed viser aldeles de samme Forhold.

Tilstedeværelsen af hypodermale Seneceller var fremdeles let at konstatere hos en lille Bladhveps og ligeledes visse Steder, f. Eks. i Hovedet af Larven af en Myre (*Formica*); derimod kan hos sidstnævnte Forholdene andetsteds være betydelig vanskeligere at forstaa, saaledes som ved Befæstningspunkterne for de Muskler, der tjene til at bevæge Kroppens Led indbyrdes, og som paa Snit ses buformigt at forene disse (Fig. 12). Under Chitinens to Lag, af hvilke det ydre breder sig tap-

formigt udfor Muskelfæstet, ligger dels den almindelige, kerneholdige Hypodermis, dels et stærkt fibrillært Parti uden Kerner, til hvilket de to Muskler fæste sig. Den naturligste Forklaring kan kun være i dette at se et omdannet Afsnit af Hypodermis, thi vel synes, efter Seriesnit at domme, Kerner stedse at mangle inde i dette, men de kunne i hvert Fald ligge tæt op dertil; desuden er det aldeles umuligt at drage en bestemt Grænse mellem det seneagtige Parti og den uomdannede Hypodermis, idet sidstnævntes netformige Protoplasmastruktur fortsætter sig ind mellem Fibrillerne; endelig farves disse Dele ens og med en ganske anden Farvetone end Musklen. Denne ender her, ganske paa samme Maade som tidligere beskrevet, midt i en lys Skive paa den saakaldte Mellemskives Plads; i god Overensstemmelse med at der her i den lyse Skive desuden findes to fine „Biskiver“, ser man udenfor den yderste brede, mørke Skive endnu en ganske lin, mørk Linie. Nogen tydelig Basalmembran har jeg ikke kunnet opdage, men da Protoplasmanetværket mellem Fibrillerne i Epithelet indadtil danner en ganske regelmæssig Grænselinie, kan man let tro at se en saadan.

Endnu sværere at forstaa er et Muskelfæste til Undersiden af første Bryst-ring (Fig. 13); vi se her et Par Muskeltraade, der styre lige hen imod Hypodermis; efter at have mistet deres Tværstribning synes de at gennembryde denne for endelig at fæste sig til Chitinen, der udfor Insertionsstedet viser en ejendommelig farvet Skygge; det er dog kun de to mellemste, der ere synlige i deres fulde Forløb. Dette Muskelfæste har en ikke ringe Lighed med et af de ovenfor (Fig. 5) beskrevne; Hovedforskellen er utvivlsomt kun den, at medens hos *Periplaneta* de enkelte Muskelprimitivbundter i Bredde svare til flere Epithelceller og desuden ligge tæt op til hinanden, ere de derimod hos Myrelarven saa smalle, at de end ikke kunne spænde over en enkelt Celle, og ligge tilmed spredte i nogen Afstand fra hinanden. Heraf følger det nu ganske naturligt, at medens i første Tilfælde Hypodermiscellernes Protoplasma er bleven fibrillært uddannet i deres hele Udstrækning, er det i sidste Tilfælde derimod kun den mindre Del af en Celles Omraade, der ligger lige udfor en Muskeltraads Ende, som fremtræder med en fibrillær Bygning. Kerner synes i intet af disse to Tilfælde at findes inde i de af tætstillede Fibriller dannede Bundter; heller ikke er Grænsen mellem Muskel og Epithel angivet ved nogen tydeligt fremtrædende Basalmembran.

Den Antagelse, at det kun er en Del af vedkommende Epithelcellers Omraade, som er bleven fibrillært omdannet, kunde maaske alligevel se ret dristig ud; for ikke at danne sig en falsk Forestilling om Forholdene bør man—dog erindre, at selv hvor Epithelcellerne i deres hele Udstrækning tjene som Muskelfæster, er Protoplasmaets Omdannelse dog aldrig absolut; imellem Fibrillerne og om Kernen findes stedse en større eller mindre Mængde uomdannet Protoplasma i Skikkelse af et fint Netværk. Til Slut maa det ikke overses, at Antagelsen af Muskels direkte Insertion til Chitinen er forbunden med mindst lige saa betydelige Vanskeligheder. Det kan nemlig i saa Fald ikke andet end være paafaldende,

at den kontraktile Substans holder op i ganske samme Afstand og paa aldeles samme Maade som ellers; men endvidere nødes vi til at antage en andetstedsfra aldeles ukendt og gennemgribende Omdannelse af Muskulens distale Ende, der tilmed maa antages at have faaet Evne til at danne Chitin. Alt dette gør, at jeg ogsaa i dette Tilfælde kun kan se en Modifikation af de allerede tidligere omtalte Bygningsforhold *).

De følgende Figurer vise nogle Muskelfæster hos Coleoptererne; den første (Fig. 14) er af Overlæben af Larven til en lille Vandkalv (*Ilybius obscurus* Marsh.); den er egentlig kun medtagen for at vise, at ogsaa hos Billerne genfindes aldeles typisk de fibrillære, hypodermale Seneceller, hvad man iøvrigt var berettiget til at vente efter Beskrivelsen hos LEYDIG. Den ejendommelige Overgang, som samme Forfatter beskriver mellem Muskel og Epithel, har jeg derimod ikke kunnet bekræfte; jeg er temmelig sikker paa, at den kun er fremkommen ved mindre god Konservering af Materialet.

Et meget afvigende Udseende har derimod et Muskelfæste (Fig. 15) i Underlæben af samme Dyr. En smal Muskel løber her næsten parallelt med Overfladen hen imod et tykkere Parti i Chitinen, til hvilket den insererer sig; ved første Øjekast tænker man sig, at den er fæstet ved et af de saa vel kendte chitinose Apodemata, men dette seneagtige Partis mørke Farve og skarpe Grænse mod Chitinen er da paafaldende. Endelig viser der sig et Par langstrakte Kerner indesluttede i Senen, og ser man tilmed hen paa, hvorledes de tilgrænsende Hypodermisceller lægge sig op om den, tror jeg næppe, man kan betænke sig paa at forklare denne „Sene“ som dannet af et lille Knippe stærkt forlængede Hypodermisceller. Muskulens Grænse udadtil er allerede ved Tværstribningsens Ophør tydelig; Sarcolemmaet, der har hævet sig fra den kontraktile Substans og danner karakteristiske smaa Buer, der gaa til Midten af de lyse Skiver eller rettere fra den ene tynde, mørke Skive til den anden, fremhæver kun denne Grænse, idet det ender, hvor det seneagtige Partis Fibriller fæste sig til Musklen; at dette sker højere oppe paa Muskulens ene Side end paa den anden, skyldes Primitivbundternes ulige Længde.

Et smukt Eksempel paa et Muskelfæste af den lige beskrevne Art har jeg fundet i sidste Bagkropsring hos Larven af en Klaner (*Anthrenus varius* F.). Ogsaa her (Fig. 16) er Musklen fæstet til Chitinen ved et kerneholdigt Seneparti, men

*) Senere Tilføjelse. Hos JANET findes en Del Billeder, der stemme overens med dem, jeg har truffet hos Hvepser og Fluer (Fig. 11, 12, 21); ligeledes svarer den Opfattelse, han fremsætter i sidstnævnte Afhandling i Hovedpunkterne til min, iøvrigt aldeles selvstændigt vundne. Dog deler jeg absolut ikke den Anskuelse, at Støttefibrillerne ere chitiniserede, idet de efter Farvning ingenlunde vise Overensstemmelse med Chitinen, ja ikke engang med dennes inderste for Farvestoffer mest modtagelige Lag. Heller ikke er det lykkedes mig at iagttage deres Indtrængen i Chitinens indre Lag, og det er min Formening, at denne Angivelse skyldes en Fejltydning af de ovenfor omtalte farvede Skygger i Chitinen udfor Muskelfæsterne; hvorfor de endelig kun skulde gennemtrænge de inderste Lag, forstaar jeg ikke, da de dog ved Dannelsen af den ny Chitin for Hudskiftet nødvendigvis (efter JANET's Opfattelse) maatte „indstøbes“ ogsaa i dennes yderste Lag.

dette er sammensat af overmaade talrige Celler, der tilmed ere smallere og mere forlængede end i det afbildede Snit af *Ilybius*, hos hvilken jeg iøvrigt har set dem ikke ubetydeligt længere. Meget smukt ses Overgangen mellem den uomdannede Hypodermis og de omdannede Seneceller; den store Hob Celler, der ligger til den ene Side, har næppe noget direkte med Muskelfæstet at skaffe, men er sikkert kun en Samling endnu udifferentierede Celler, der ville finde Anvendelse under den nær forestaaende Puppehvile. Betydningen af de to store Cellekerner, der ses over Senen, er mig ubekendt; maaske høre de til vandrende Bindevævsceller, maaske til det blærede Væv, som omgiver alt og naturligvis er Forraadsvæv; de tomme Hulrum i sidstnævnte have omsluttet Oljedraaber.

Af samme Dyr, men fra Rygsiden af anden Brystring, er næste Afbildning (Fig. 17) taget. Chitinen er her paa et enkelt Sted stærkt fortykket, men navnlig gælder dette Hypodermis. I denne ses en hel Række fint længdestribede Dannelser, der utvivlsomt ere fremkomne ved, at Fibrillerne indenfor de enkelte Celler have sluttet sig sammen til Bundter; de ere smalle ved den distale, brede ved den proximale Ende, med hvilken de slutte sig til hinanden og til et fint Grænselag, der afgiver Fæste for de tydeligt tværsribede Muskler. Kernerne i Hypodermis ligge imellem Fibrilbundterne, omgivne af noget uomdannet Protoplasma. Det uomdannede Epithel er ogsaa her usædvanlig kernerigt; et Par store, klare Celler deri ere muligvis at opfatte som encellede Kirtler, der have Betydning under Hudsiftet.

Man maa nu ikke tro, at hos den omtalte Klanerlarve Muskelfæsterne altid ere af saa afvigende Art; de fleste, man træffer, ere tværtimod af saa velkendt Art, at de ikke behøve videre Omtale. Det samme gælder de øvrige Typer, jeg har undersøgt: Imago af *Silpha*, Larver af *Cetonia*, *Pyrochroa* og *Rhagium**), ihvorvel der naturligvis findes en Del Forskelligheder i den finere Bygning. Hos *Cetonia* ser man saaledes, efter Farvning med Eosin eller Orange G, i Chitinlaget udfor Muskelfæstet en stærkt farvet Skygge; det samme kan ses hos Myrelarven (Fig. 13) og vil senere blive omtalt under Fluerne; Grunden hertil maa søges i en særegen kemisk Beskaffenhed af Chitinen, der iøvrigt her, aldeles som ellers, viser sin typiske Sammensætning af parallelle Lag.

Blandt Lepidoptererne er hos Larven af det almindelige Møl (*Tinea pellionella* L.) Hypodermis overalt dannet af uhyre lave Celler; ikke desto mindre er det ingenlunde vanskeligt med største Tydelighed at se dette Lag med dets flade Kerner ligge mellem Muskel og Chitin. Større og derfor lettere at forstaa ere Forholdene hos andre Sommerfuglelarver, f. Eks. hos *Agrotis*, hvor Epithel-udfor Musklerne viser sig paa sædvanlig Vis fibrillært omdannet. Kerner ses ofte i Fibrilmassen udfor de brede Muskler, men synes at kunne mangle udfor de smalle; en udpræget Basalmembran har jeg ikke set.

*) Hertil kan fojes Larven af Kartoffelbillen (*Leptinotarsa decemlineata* Say.), idet jeg ikke tager i Betænkning at fortolke en af Tower (Zool. Anz., XXV, 1902) given Figur som et tydeligt Eksempel paa indirekte Fæste.

Som tidligere nævnt har ANTON SCHNEIDER angivet (hos Larven af *Saturnia*) et direkte Fæste af Musklerne til Chitinen; imidlertid have denne Forfatters Figurer et saa skematisk *) Udseende, at de ikke kunne gøre Fordring paa større Tiltro. Det mærkeligste er dog, at medens det angives som almindelig Regel, at Muskel-fibrillerne stedse skulle gaa gennem Epithelet helt hen til Chitinen, ses de dog paa en af Figurerne tydeligt nok skilte derfra ved Hypodermiscellernes Protoplasma og Kerner; det nævnte Snit, der ikke er betegnet som tangentielt, er fra Endetarmen, om hvilken det udtrykkelig angives, at Muskelinsertionen er som i Kropvæggen.

En særlig indgaaende Undersøgelse fortjene Diptererne, idet nogle af de mest bestemte Angivelser om direkte Insertion ere hentede fra denne Orden; at Forholdene dog ikke altid ere saaledes, har, som det vil erindres, Holmgren paavist. Tilstedeværelsen af fibrillært omdannet Hypodermis af sædvanlig Art er nu i Virkeligheden ogsaa meget iøjnefaldende hos mange Former; saaledes hører, hos Larven af en *Tipula* (Fig. 18), den mørktfarvede Zone, der ligger mellem Muskulens kontraktile Substans og Chitinen (der paa dette Sted var fortykket til en mægtig, i Figuren afskaaret, haarbærende Liste), utvivlsomt Epithelet til. Kernerne deri svare ganske til de øvrige, i Hypodermis liggende Kerner og ere ikke saa lidt mindre end Muskulens; paa Siderne slutter endelig det uomdannede Epithel sig nøje til det omdannede. Grænsen mod Musklen er aldeles skarp, omend den næppe tør fremstilles med en bestemt Linie.

Muskelfæster af ganske samme Art har jeg truffet hos Larven af *Corethra plumicornis* F. samt af *Chironomus* **), omend hos sidstnævnte Epithelet er af betydelig ringere Højde; at de ogsaa kan findes hos Imagines viser et Snit (Fig. 19) gennem det ventrale Fæste af en Flyvemuskel i Brystet af en Spyflue (*Musca vomitoria* L.).

I adskillige andre Tilfælde, f. Eks. i Snit af en fra den forrige artsforskellig Larve af en *Tipula* (Fig. 20), kan man derimod til en Begyndelse meget vel faa det Indtryk, at man har med en direkte Insertion at gøre. Imidlertid kan man i Længden ikke undlade at bemærke den store Lighed, der er mellem denne og en af de foregaaende Afbildninger (Fig. 18); den eneste Forskel er i Grunden Mangelen af Kerner i det sidste Tilfælde, hvor saa til Gengæld den sig insererende Muskel er betydelig smallere; at dette Forhold virkelig har nogen Betydning, ses samtidig let hos samme Larve, idet det slet ikke er usædvanligt udfor de bredere Muskler at finde Kerner i den fibrillære Masse. Som Støtte for det fibrillære Partis epitheliale Natur vil jeg fremhæve, at det hænger aldeles kontinuerligt sammen med den øvrige Hypodermis, at dennes Basalmembran netop forløber nøjagtig i Retning henimod Grænsen mellem den fibrillære og den kontraktile Substans, samt at Sarcolemmaet, naar det har hævet sig fra denne, ligeledes tydeligt ses at løbe

*) Det maa i saa Henseende være nok at henvise til det besynderlige „innere Grenzschicht der Hypodermis“ med dets Overgange i Sarcolemma' og i Neurilemma.

**) Hos denne Form samt hos *Stratiomys* har WEISMANN forlængst paavist, at Muskelanlæggene ved et bindevævsagtigt Cellelag (s: Hypodermis) ere skilte fra Chitin og Chitinsene.

sammesteds hen *). Det er utvivlsomt Muskelfæster af denne Art, der af PANTEL, HECHT og HOLMGREN ere afbildede og fortolkede som Eksempler paa direkte Insertion. Den mørke, svagt længdestribede Skygge, der ses i Chitinen i Forlængelse af det fibrillære Hypodermisafsnit, kan efter min Anskuelse kun skyldes en Afgivelse i Chitinens kemiske Beskaffenhed; saa tydelige Længdestriber, at der skulde kunne være Tale om, med HECHT, at anse dem for dannede af Fibriller, der fortsætte sig helt ud gennem Chitinen til dennes Overflade, har jeg aldrig iagttaget; de svage, man ser, skyldes sikkert kun Folder, der gaa gennem alle Chitinens Lag.

Muskelfæster af samme Type har jeg desuden fundet hos Larven af *Simulium* samt hos en i en Svamp levende Larve af en *Cecidomyia*; navnlig hos den sidste gør den overordentlig tynde Hypodermis sig kun meget lidt gældende, men lader sig stedse paavise, stundom endog med Kerner, imellem de smalle Muskler og Chitinen.

Dernæst maa jeg henlede Opmærksomheden paa en ejendommelig Art af Muskelfæster, som jeg har fundet ved Vingemusklerne af forskellige Fluor, f. Eks. *Musca vomitoria* L. Afbildningen (Fig. 21) viser en mindre Del af et stort Knippe saadanne Muskler ved deres Fæste til Vingens Rod; med deres anden Ende fæste de sig, som ovenfor (Fig. 19) paavist, til sædvanlige, fibrillært omdannede Hypodermisceller. Man ser, hvorledes de enkelte Muskelbundter træde i Forbindelse med Chitinen ved lange traadformede Dannelser; disse, som ved Foldninger af Snittet fremtræde noget uregelmæssigt bøjede, ere i deres proximale Del kegleformigt opsvulmede, vise en fin Længdestribning og bære en langstrakt Kerne trykket op til deres brede Del. Deres betydelige Længde kan sætte en i Uvished om, hvorledes de ere at forstaa; da man imidlertid ved at lede den hele Snitserie igennem let finder alle Overgange fra disse stærkt forlængede Dannelser til andre, som ere betydelig kortere (hvad der allerede ses i det afbildede Snit), og fra disse igen til de sædvanlige lave Insertionsceller (Fig. 19), nærer man mindre Betænkelighed ved i hver saadan Senetraad at se en omdannet Epithelcelle**). Til Sammenligning bor man desuden betragte visse ovenfor hos en Vandkalvelarve (Fig. 15) og hos en Klanerlarve (Fig. 16) beskrevne Forhold; tænker man sig Fluens talrige lange Seneceller rykkede tæt sammen, vilde Billedet i alt væsentlig stemme med disse Figurer.

Det er indlysende, at disse af stærkt forlængede og indbyrdes uafhængige Celler dannede Sener maa have en særlig Betydning ved Muskelinsertionen; for

*) Dette ses godt paa Figuren hos HECHT, der synes at være ganske nøjagtig, men gengiver et kun tarveligt fikseret Preparat; man se kun, hvorledes Chitinens Matrixceller ikke engang allevegne slutte op til Chitinen!

**) Senere Tilføjelse. Jeg vil ikke undlade til Sammenligning at henvise til JANET¹³⁾, der foruden adskillige andre oplysende Figurer giver et med det lige beskrevne nøje overensstemmende Billede (loe. cit. Fig. 3, F.), hvor endog de til de langstrakte Seneceller hørende Kerner tydeligt ere at se. Deres Plads skal iøvrigt her (hos *Myrmica rubra* L.) være midt inde i Fibrilmassen, og Forfatteren ser i dem en i Spidsen af Muskelsubstansen isoleret liggende Kerne. Den rette Forklaring af disse Dannelser er iøvrigt først senere fremsat af JANET¹⁴⁾, hvis Arbejder var mig aldeles ukendte, da ovenstaaende blev nedskrevet.

det første kan naturligvis ved Hjælp af saadanne en stor Mængde Muskler komme i Forbindelse med et Chitinparti af et ret begrænset Omfang, men dernæst kan der sikkert heller ingen Tvivl være om, at hver enkelt Muskeltraad samtidig vil kunne virke med langt større Selvstændighed.

Ved sin Antagelse, at Muskelinsertionerne skulde kunne optræde i ikke mindre end tre grundforskellige Skikkelser, indtager HOLMGREN en Særstilling. Et Blik paa hans Figur af „den direkte Insertion“ (loc. cit. Fig. 4) viser dog straks dennes store Overensstemmelse med en af mine egne (Fig. 20), hvorfor jeg da heller ikke tager i Betænkning at fortolke den paa ganske samme Maade. Hans Afbildning af „et indirekte Fæste“ gør ikke noget særlig troværdigt Indtryk, og i Præparater har jeg aldrig set noget nøje tilsvarende; dog vil jeg ikke opholde mig længere herved, da det tidligere er tilstrækkeligt paavist, at de hypodermale Senepartier hos samme Dyr kan variere meget betydeligt. Tilbage staar Figuren af HOLMGREN's „anden Insertionsmodus“, der skulde svare til de af FRENZEL beskrevne Forhold; ogsaa mod den maa jeg desværre gøre nogle Indvendinger. Jeg kan saaledes ikke indse, hvorledes den tynde Traad, der udspringer fra Musklen, og hvis Grene, lidt før de naa Chitinen, sprede sig hver i en Fibrilkegle, kan virke som en Sene ved Muskens Kontraktion; den sidder tværtimod som en underlig, løst paaklistret Dannelse paa Siden af Muskeltraaden, der uforandret fortsætter sig forbi dens Tilhæftningssted. Det er mig uforstaaeligt, hvorledes man af en saadan Figur skal kunne få det Indtryk, at Musklen ved Epithelets Grænse deler sig i et Antal Grene, der omspinde Epithelcellerne.

Jeg hælder stærkt til den Anskuelse, at der her foreligger en fejlagtig fortolket lagttagelse, navnlig da, naar jeg ser hen til de Fund, jeg har gjort paa Tværsnit af den bageste Del af Æggelederen, „Skeden“ *) af *Sarcophaga carnaria* L. (Fig. 22). Her ses under (α) paa den konkave Side af) Chitinlaget Hypodermis og under denne en lang tynd Ringmuskel, der er noget uens contraheret, stærkest udfor de store Bugter i Chitinen, hvor følgelig ogsaa dens Sarcolemma har hævet sig i størst Bue fra Muskelsubstansen. En særlig Opmærksomhed fortjene de fine Forbindelsesbroer, som Epithelcellerne udsende henimod Musklen, og som ligge med ganske regelmæssige Mellemrum, idet hver fæster sig til Muskeltraaden udfor en smal, mørk Skive. Protoplasmaet i disse Forbindelsesbroer synes sammensat af en traadet Masse, der længere ude mod Overfladen gør Indtryk af at spredes kegleformigt.

Disse Dannelser bør naturligvis ikke sammenstilles med de sædvanlige hypodermale Senepartier, idet saadanne ogsaa træffes ved de her omtalte Ringmusklers Ender; derimod spille de utvivlsomt en betydningsfuld Rolle under Muskens Kontraktion, idet deres Opgave rimeligvis er at holde Musklen i passende Nærhed af Chitinen og samtidig hindre denne i et enkelt Sted at slaa alt for store Bugter.

*) Dette Objekt er ingenlunde særlig gunstigt for disse Undersøgelser, idet Chitin og Hypodermis gennemgaaende ligge altfor meget i Folder og Epithelcellerne desuden ere forholdsvis smaa.

Hvis jeg skulde sammenligne dem med noget andet i Literaturen omtalt, maatte det være med de Støttetraade, der findes i Gællefødderne hos visse Krebs og ere beskrevne f. Eks. hos DUBOSQ, J. KIMUS (La Cellule, XV, 1898) og K. C. SCHNEIDER²⁹). Disse ere ligeledes dannede som indadrettede, fibrillære Forlængelser af visse Epithelceller og antages at have den Rolle som Støttepiller at forbinde de to Flader i det tynde Blad og derved hindre disse i at spiles ud fra hinanden af Blodtrykket.

Disse Støttetraade ere nu det eneste, jeg har kunnet finde, som viser nogen Lighed med den omtalte Figur hos HOLMGREN^{*)}; det passer hermed meget vel, at den tynde Traad udspringer fra Musklen just udfor en tynd, mørk Skive, dog er der unægtelig den meget væsentlige Forskel til Stede, at den hos HOLMGREN er fremstillet grenet, noget, jeg aldrig har iagttaget ved de omtalte Støttetraade; maaske kunde dette dog skyldes en lagtagelsesfejl, der saa meget lettere maatte kunne indtræffe, som Snittet efter Kernernes Antal at dømme ikke har været særlig tyndt.

Hvis denne Opfattelse er rigtig, er det klart, at vi heller ikke her have noget Eksempel paa direkte Insertion, men selv i det modsatte Tilfælde kan jeg ikke se noget til Hinder for at antage, at de ikke tværstribede Grene, som „omspinde Epithelcellerne“ i Virkeligheden ere dannede indenfor Hypodermis; at de bestaa af Muskelfibriller, omgivne af et tyndt Sarcoglia³⁰lag er nemlig, saavidt jeg kan se, en blot og bar Paastand, som desværre adskilligt tilsvarende i nævnte Afhandling; heller ikke tør jeg lægge nogen Vægt paa, at de enkelte Grene tydeligt nok synes at ligge mellem Hypodermiscellerne, saasom jeg nærer en ikke ringe Tvivl om Tilstedeværelsen af disse i Figurerne saa fremtrædende Cellegrænser.

Alt i Alt maa jeg saaledes bestemt fastholde, at heller ikke Holmgren har fremfort nogetsohmhelst afgørende Vidnesbyrd om Forekomsten af direkte Muskelinsertioner hos Diptererne.

Hos den sidste Orden af Insekter, jeg har undersøgt, hos Hemiptererne, har jeg ligeledes stedse fundet indirekte Muskelinsertion. Epithelet synes som Regel at være ganske lavt, men meget let at erkende paa Grund af de talrige flade Kerner. Det er dog ikke udelukket her stundom at finde store, forlængede Seneceller; saaledes har jeg hos *Notonecta* truffet et Muskelfæste af ganske lignende Udseende som hos *Periplaneta* (Fig. 5). Bladlus (Aphider) og Skjoldlus (Coccider) vise den fladeste Hypodermis, jeg overhovedet nogensteds har set; de Steder, hvor man lettest kan iagttage de hypodermale Seneceller, er utvivlsomt Muskelfæsterne i Benene; Farvemodsætningen mellem Muskel og Epithel ses her ofte meget tydeligt, Fibriller i Epithelet derimod langt vanskeligere paa Grund af dettes ringe Højde.

*) Samme Forfatter viser i en anden Figur (loc. cit. Fig. 7) hvorledes „ein Sarcogliafortsatz einer Muskelzelle mit dem Zellkörper einer Epithelzelle (Matrixzelle des Chitins) in völlige Continuität steht“. Men ikke en af de omtalte epitheliale Forbindelsesbroer skulde danne denne „Sarcogliafortsatz“?

Myriapoder.

Til den Fremstilling, som DUBOSQ giver, vedrørende Chilopoderne, kan jeg i Hovedsagen slutte mig*), ihvorvel jeg nærer Tvivl om visse Enkeltheder, saaledes som den paastaaede Overgang mellem det uomdannede Epithels Basalmembran og Sarcolemmaet eller den absolute Mangel af en Basalmembran mellem Musklen og de epitheliale Seneceller; rimeligvis maa det ogsaa bero paa en Misforstaaelse (f. Eks. af en meget uens kontraheret Muskel), naar Tværstribningen angives at forsvinde et Stykke fra Epithelet; jeg har i hvert Fald hverken her eller andetsteds iagttaget noget saadant.

Arachnider.

Af denne Klasse**) har jeg kun undersøgt et Par Edderkopper: *Argyroneta aquatica* L., *Epeira* og *Clubiona*. Blandt disse er en saa pigmenteret Form som *Argyroneta* ikke særlig egnet til Undersøgelse i denne Retning; thi ganske vist ses den stærkt pigmenterede Hypodermis som en uafbrudt sort Strihe under Chitinen, ogsaa paa Steder, hvor Muskler fæste sig, men Pigmentet hindrer samtidig ethvert nøjere Studium af Cellernes Struktur. Derimod ses hos en *Clubiona* overalt med største Tydelighed de hypodermale, fibrillære Seneceller, hvis Tilstedeværelse hos Edderkopperne iøvrigt forlængst er konstateret af BERTKAU. At de gamle Angivelser hos LEYDIG og WAGENER om Overgang mellem Muskelskede og Chitin kun skyldes Mangel paa den rette Forstaaelse af Chitinsenen, behøver jeg ikke nøjere at omtale; Laarmusklerne, som WAGENER har undersøgt, vise netop meget smukt, hvorledes de meget lange Chitinsener ere dannede som hule Indkrængninger af Overfladens Chitin. Den af WAGNER fremsatte Paastand, at Hypodermis skulde mangle paa disse Chitinsener, er, som et hvilket som helst Snit viser, aldeles uholdbar, og ikke bedre forholder det sig utvivlsomt med samme Forfatters øvrige mærkelige Meninger, der sikkert kun behandles efter Fortjeneste, naar de forbigaas i fuldstændig Tavshed.

Crustaceer.

Ved Undersøgelsen af disse Dyr vil jeg begynde med en Repræsentant for Phyllopodernes Orden, med *Brauchipus Grubii* Düb., idet jeg først henviser til en

*) Jeg er saaledes absolut uenig med Rossi²⁶⁾, der i en mig utilgængelig Afhandling mod DUBOSQ hævder, at Musklerne gennembryde det hypodermale „Syneytium“ og fæste sig paa Chitinen.

**) For Pentastomernes Vedkommende findes hos LOHRMANN²¹⁾ og hos SPENCER³²⁾ Angivelser om direkte Muskelinsertion. Da jeg ikke selv har kunnet undersøge disse Dyr, maa jeg her indskrænke mig til den Bemærkning, at de nævnte Forfatteres Figurer efter mit Skøn lige saa vel kunne fortolkes i den modsatte Retning.

let forstaaelig Afbildning (Fig. 23) der stammer fra Hovedets Underside. Under det tynde Chitinlag ses Hypodermis med sine store Cellekerner; den er indadtil begrænset af en ret uregelmæssig, fin Linie, en Basalmembran, der med Syrefuchsin-Pikrinsyre antager en rød Farvetone. I Epithelet ses Grupper af Fibriller, netop udfor de Steder, hvor fine Muskelbundter fæste sig til Basalmembranen*); saavel efter Farvning med Hæmallun-Orange som med Syrefuchsin-Pikrinsyre fremtræde Epithelets Fibriller kendelig blegere end Musklen. Det ejendommelige Udseende, Musklen viser, idet den et enkelt Sted er betydelig mørkere og tydelig tværstribet, skyldes kun en Kontraktionshølge paa det nævnte Sted.

Idet nu den nævnte Basalmembran andetsteds naar en aneligere Udvikling, føres vi derigennem til visse højst ejendommelige Muskelfæster, der iøvrigt forlængst ere iagttagne af CLAUS. Vi se i et Snit gennem Nakken af Dyret (Fig. 24), hvorledes Epithelet lidt efter lidt naar en anelig Højde; Kernerne, der før laa parallelt med Chitinen, danne derved en tydelig Vinkel med denne. I Epithelet ses Bundter af Fibriller, der gaa fra Chitinen hen til et ejendommeligt, bindevævsagtigt Parti, til hvilket Musklerne fæste sig; disse sidste ere trufne i en Retning, der er ikke saa lidt afvigende fra Muskelbundtets Længderetning; deraf er Følgen, at man kun ser en lille Stump af den distale Ende af den kontraktile Substans, omgivet af et klart Rum, der indeholder et Par Kerner og er fremkommet ved, at Sarcolemmaet blæreformet har hævet sig fra Muskelsubstansen. Fibrillerne i Epithelet ligge samlede i Bundter, der ere fæstede til korte Udløbere af den bindevævsagtige Dannelse; jeg kan dog ikke tro, at der er nogen virkelig Sammenhæng tilstede her, idet disse Dele farves saa højst forskelligt; med Syrefuchsin-Pikrinsyre blive Fibrillerne gule, det øvrige derimod stærkt karmesinrødt; den tilsyneladende Sammenhæng skyldes sikkert kun den Omstændighed, at Fibrillerne lægge sig nøje op til de distalt noget uregelmæssigt endende Udløbere fra det subepitheliale Støtteparti. Dette, der naar sin aneligste Tykkelse udfor Midten af Muskelfæstet, og som til Siderne synes at gaa over i den almindelige Basalmembran, maa vist, navnlig i Betragtning af de indadgaende Forlængelser, opfattes som dannet af Bindevæv, som iøvrigt MAYER antager; at det skulde bestaa af Chitin, hvad CLAUS støttet til grumme svage Beviser, antog, er, efter MAYER, ligesaa usandsynligt som CLAUS' Opfattelse af Hypodermis som et Bindevæv.

I øvrigt er det forbavsende, saa meget Besvær Forstaaelsen af de her omtalte Billeder har voldet saavel CLAUS som i nyeste Tid K. C. SCHNEIDER²⁹). Begge mene, at Epithelcellerne kun danne et forholdsvis lavt Lag paa Chitinens Inderside;—men at de om Fibrillbundterne ere trukne ud i indadrettede Forlængelser, der som Støttebjælker bære det indre Støtteparti. De Rum, der findes mellem disse Bjælker, opfattes som Lymferum og angives at indeholde Lymfeceller. Det sidste forholder

*) Dette Præparat viser udmærket, hvor nøje de seneagtige Fibrillers Beliggenhed i Epithelcellerne afhænger af Muskeltraadernes Insertionspunkter; det svarer i den Henseende fuldstændig til et tidligere beskrevet (Fig. 13).

sig nu ganske rigtigt, men er uden afgørende Betydning, da saadanne Vandreceller ogsaa hyppigt træffes andetsteds*), selv hvor Hypodermis er et ganske lavt Epithel. Da desuden Overgangen mellem de lavere og de højere Epithelpartier er ganske jævn, og endvidere de omtalte Bjælker paa godt fikserede Præparater slet ikke vise sig som tydeligt afgrænsede Piller, adskille ved lakunose Rum, men ligge i et fint netformigt Protoplasma, kan jeg ikke se nogen Grund til en fra alt, hvad vi ellers kende, saa afvigende Opfattelse af disse Cellepartier. Ved den omtalte, mægtige Bindevævsdannelse afviger dette Muskelfæste fra de tidligere beskrevne og hører egentlig til den vidt udbredte, men i dette Arbejde iøvrigt ikke omtalte Gruppe af Muskelinsertioner til Bindevævsmasser; at det ikke er forbigaaet her skyldes dels den Omstændighed, at det tidligere ikke har været fuldt forstaaet, dels at det er et ypperligt Eksempel paa, hvorledes Fibrillerne i Epithelet og i Muskulaturen kan være tydeligt adskillede fra hinanden og i hvert Fald i et saadant Tilfælde næppe kan antages at have nogen genetisk Sammenhæng.

Hos *Nebalia***) har nylig LABBÉ¹⁶⁾ nøje beskrevet Forholdet mellem Musklen og de med „Tonofibriller“ udstyrede Hypodermisceller; jeg maa hertil dog føje den Bemærkning, at jeg nærer megen Tvivl om, hvorvidt den Basalmembran, der adskiller Musklen fra Epithelet, virkelig delvis er dannet af den sidste tynde, mørke Skive i Muskeltraaden; da jeg, som nævnt, andetsteds har set den antage en rød Farvetone med Syrefuchsin, kan jeg ikke tro andet, end at den kun ligger paa dennes Plads***).

Den næste Afbildning (Fig. 25) fremstiller et Muskelfæste i et af Lemmerne af en Cirriped, *Balanus improvisus* Don. Da Epithelet her, hverken udfor Musklerne eller andetsteds viser nogen fremtrædende Basalmembran, kan det selvfølgelig være vanskeligt aldeles nøjagtigt at paapege Grænsen mellem den meget fint tværstribede Muskel og de hypodermale Seneceller; om direkte Insertion kan der dog ikke være Tale, da (efter Farvning med Hæmaliun-Orange) Musklen fremtræder stærkt gul, Senepartiet derimod blaat, og sidstnævnte tilmed ved sine talrige Kerner og sit rigelige Indhold af Pigmentkorn stemmer nøjagtig med den øvrige Hypodermis. For Resten er den indirekte Insertion allerede tidligere omtalt hos Cirripederne,

*) Ogsaa hos andre Former (Fig. 27).

**) Saavel for denne Form som for Ostrakoderne angiver CLAUS^{5, 6)}, at Musklerne eller disses „Senetraade“ gennembryde Hypodermis og tage Fæste paa Chitinen; disse Angivelser have dog sikkert kun anatomisk, ikke histologisk Værdi.

*** Tilføjelse under Korrektoren. Det indirekte Fæste hævdes fremdeles som typisk for Krebsdyrene af S. MAZIARSKI, der i sin Afhandling: Sur les rapports des muscles et de la cuticule chez les Crustacés (Bull. Int. Acad. Sc. Cracovie, 1903) beskriver, hvorledes saavel hos *Mysis* som hos Copepoder og hos *Phronima* Musklerne inserere sig til Chitinen ved Hjælp af Epithelceller, hvis Protoplasma har uddannet særegne Fibriller eller „Tonomitomer“; sidstnævnte staa med den ene Ende i Forbindelse med Chitinen, medens den anden i Højde med Hypodermis' Cellemembran fæster sig til Muskelfibrillerne, som afslutte med den tynde, mørke Skive. I Antal skal Epithelets Fibriller svare til Muskens og til begge Sider ende med en lille Opsvulmning; deres Betydning er at fæste Musklen til Cuticula og samtidig at yde Modstand mod den mekaniske Virkning, der øves ved dens Kontraktion.

idet KOEHLER¹⁵⁾ har beskrevet, hvorledes hos Lepaderne Musklerne grene sig stærkt for tilsidst at fæste sig til Epithelcellerne med penselformig udsprede Ender; saadanne har jeg dog ikke truffet hos den undersøgte *Balanus*.

Hos de terrestriske Isopoder beskriver PANTEL Forholdene ganske som hos Larven af *Thraxion*, idet han antager, at Musklerne med seneagtig omdannede Ender fæste sig direkte til Chitinen; min Afbildning (Fig. 26) af den nærstaaende Form *Asellus aquaticus* L. viser tydeligt, at det utvivlsomt falder langt simplere ogsaa her at opfatte det fibrillære Parti som omdannede Epithelceller, saa meget mere som en iøjnefaldende Basalmembran danner en skarp Grænse mellem de to Afsnit.

Ogsaa hos Amphipoder, f. Eks. hos en neapolitansk *Phronima*, genfindes let de epitheliale Seneceller, ihvorvel de, ligesom hele den øvrige Hypodermis, ere indskrænkede til et meget tyndt Lag.

I stærk Modsætning hertil staar SCHÖNICHEN's Angivelse, at Musklerne i Oesophagus af Oniscider og Asellider gennembryde Epithelet og, stadig tydeligt tværstribede, fortsætte sig lige ud til Chitinen. Ved at gennemgaa et Par ganske fuldstændige Snitserier gennem vedkommende Del af *Asellus*, er jeg dog kommen til det Resultat, at det ikke et eneste Sted er muligt at paavise tværstribet Muskelsubstans fæstet til Chitinen, men at der tværtimod stadig mellem disse to Substanser er indskudt et særegent, svagt længdestribet, seneagtigt Parti (Fig. 27). Dette Muskelfæste faar saaledes stor Lighed med et tidligere omtalt (Fig. 13), og jeg nærer heller ikke nogen Betænkelse ved ogsaa i dette Tilfælde at anse Senerne for særligt uddannede Partier indenfor visse af Epithelcellerne*). En Omstændighed, der gør, at man let lader sig fore vild, er, at Muskulens distale Ende ofte ligger lidt indsenket i Epithelet; paa saadanne Steder ser man, hvad jeg har søgt at antyde i Figuren, at den ganske fine Basalmembran bøjer sig ned som en Skede om Musklen; den kan muligvis endog paavises mellem Musklen og dennes Sene, i hvert Fald synes dette mig den mest nærliggende Forklaring af en ejendommelig skarp Linie, der f. Eks. ses distalt at afslutte den længst til højre liggende Muskel. Hvad Grunden er til, at Senepartiet her er lavere end det øvrige Epithel, kan først synes ret uforstaaeligt; betænker man imidlertid, at Epithelet, naar Svælget udvides, idet Chitinens Folder rette sig ud, utvivlsomt maa blive noget afladet, synes jeg, den Formodning ligger nær, at Senen i Højde omtrent svarer til Epithelet i det ndvidede Svælg; ved dettes Sammentrækning beholder Senepartiet sin Længde, medens derimod de almindelige Epithelceller danne et noget tykkere Lag-og der- ved svulme op om Musklernes distale Ender.

Nær hertil slutte sig uden Tvivl de Bygningsforhold, som FRENZEL har skildret i Endetarmen hos en Del Dekapoder. Musklerne klovede sig her i det subepitheliale

*) Lignende Billeder ligge rimeligvis til Grund for IDE's Angivelse om direkte Insertion i hans mig utilgængelige Arbejde over Hedriophthalmernes Fordøjelseskanaal; det er under alle Omstændigheder ikke lykkedes mig at finde andet, der kunde tænkes at støtte en saadan Paastand.

Lag i flere Grene, der fæste sig til seneagtige Dannelser, som angives at ligge mellem Epithelcellerne, og som Forfatteren er mest tilbøjelig til at anse for Binde-væv, indskudt mellem disse; den Mulighed, at de jo ogsaa kunde tænkes dannede fra Epithelcellerne, forkaster han, saasom de ikke synes at være chitinose. I de Tilfælde, hvor den tværstribede Muskelsubstans ophører ved Epithelets Basis, vil man vel, efter alt det foregaaende, næppe betænke sig paa at anse Senerne for Fibrildannelser i Epithelet, hvorved disse Muskelfæster altsaa faa den typiske Bygning; vanskeligere bliver Forstaaelsen derimod, naar, som det angives at være Tilfældet hos *Scyllarus* og *Astacus*, Muskeltraadene strække sig ind i Epithelet nær hen til Chitinen, ja efter en af de ledsagende Figurer*) endog fæste sig direkte paa denne. Desværre har jeg ikke været i Stand til at skaffe mig Materiale til en sammenlignende Undersøgelse af en hel Række Former, hvad der utvivlsomt havde været af Interesse, men har maattet nøjes med at undersøge Flodkrebsen, hvor Forholdene dog synes særligt vanskelige at udrede. Man finder her fine radialt løbende Muskeltraade, der grene sig i Tarmens Bindevæv og strække sig hen mod Epithelet; muligvis vil man ogsaa ved den første Betragtning faa det Indtryk, at de gennembore dette og fæste sig direkte paa Chitinen, hvad iøvrigt K. C. SCHNEIDER²⁹⁾ angiver. En nøjagtigere Undersøgelse bestyrker dog langtfra denne Anskuelse; det er nemlig ikke et eneste Sted lykkedes mig at se tydelig tværstribet Muskelsubstans i Berøring med Chitinen; fremdeles ere de fine Fibriller, ved hvis Hjælp Musklen fæster sig, blegere af Farve end den tværstribede Substans, og desuden næppe til at adskille fra de talrige Støttefibriller, der iøvrigt findes i Epithelcellerne. Stundom kan Tværstribningen i Musklen være meget vanskelig at iagttage, og Forholdene ere da næsten umulige at forstaa; hvor den derimod fremtræder tydeligt, finder man Billeder som det her (Fig. 28) fremstillede, der, saavidt jeg kan se, ikke tilsteder nogen anden Forklaring end den, at Musklen standser ved Epithelets Grænse, medens Insertionen sker ved Hjælp af en Fibrildannelse i Epithelet; Forholdene her svare med andre Ord ganske til dem, der i den foregaaende Figur ere fremstillede fra Svælget af *Asellus*. At Musklerne ligesom hos denne kunne strække sig et lille Stykke ind i Epithelet, tør jeg ikke absolut benægte, men det maa sikkert ogsaa her opfattes som fremkommet paa ganske samme Maade, nemlig ved en øjeblikkelig tættere Sammenhobning af Epithelcellerne paa nævnte Sted**).

Fibrillerne i Epithelet er FRENZEL som nævnt mest tilbøjelig til at anse for Bindevævsdannelser, der strække sig ind mellem Epithelcellerne; jeg tror dog, at den anden Opfattelse, han lige antyder, nemlig at de stamme fra Epithelet, er den rette, saa meget desto mere, som der er en vis Forskel i den Maade, hvorpaa

*) Denne, der tilmed ikke svarer helt til Teksten, er efter mit Skøn egentlig det eneste, der berettiger til at anføre FRENZEL blandt de Forfattere, der hævde en direkte Insertion, thi om nogen virkelig Kontinuitet mellem Musklerne og de fibrillære Sener er der intetsteds Tale.

**) Da Tarmen saavel her som hos andre Leddyr har en Tilbøjelighed til at trække sig sammen i Længderetningen, bør man helst foretage Fikseringen medens den er in situ; undlader man dette, er man udsat for at faa stærkt fortrukne og næsten uforstaaelige Billeder.

Fibrillerne indenfor Epithelets Omraade og udenfor dette optage Farver; iøvrigt er, hvad Figuren tydelig nok viser, en skarp Grænse for Epithelet indadtil om ikke umulig saa dog vanskelig at drage.

Iøvrigt behøver jeg kun kortelig at omtale Muskelinsertionen hos Dekapoderne, da det netop er hos en af disse, hos Flodkrebsen, at den indirekte Insertion først blev paavist. Allerede REICHERT fandt nemlig et „Bindevævslag“ udfor Muskels Ende, og dette Lags Natur og Betydning erkendtes senere ved Undersøgelser af HAECKEL og BRAUN, hvilken sidste paaviste Cellernes fibrillære Struktur. Vil man overbevise sig om Rigtigheden af disse Angivelser, kan jeg henvise til Tyggemusklens dorsale Insertion som et dertil særlig vel egnet Objekt. I „Maven“ skal efter BRAUN Forholdene være som ved den ydre Hud; det samme har jeg iagttaget hos *Palæmon Fabricii* Rtk. Beskrivelser af indirekte Insertion hos forskellige Dekapoder findes fremdeles hos VITZOU og LIST; ingen af disse omtaler Fibrillerne i Hypodermis og den sidstes Angivelse, at Musklerne hos *Palæmon serratus* F. ude ved Hypodermis kun vise en Længdestribning, har jeg ikke fundet bekræftet hos *P. Fabricii*, hvor Tværstrieringen kan ses lige ud til Basalmembranen.

Chitinsenens Bygning er, som nævnt, ogsaa først bleven udredet hos Dekapoderne ved BAUR's fortræffelige Undersøgelse, af hvilken det fremgaar, at disse Dannelser i et og alt forholde sig som Indkrængninger af Overfladens Chitin.

Fornylig har K. C. SCHNEIDER²⁹⁾ afbildet et Muskelfæste til Tyggemusklens Apodema hos Flodkrebsen. Saavidt jeg forstaar, lægger han dog altfor stor Vægt paa et traadet Bindevævslag, han mener at finde indskudt mellem Musklen og Hypodermis, thi efter min Mening er et Snit som det afbildede slet ikke faldet axiaalt saavel i Forhold til Muskel som til Seneceller. Hvor dette er Tilfældet ses nemlig (Fig. 29) Musklen paa sædvanlig Vis liggende op til Epithelets Basalmembran; nævnte Figur viser iøvrigt længst til højre det omtalte Bindevæv tilsyneladende liggende mellem Muskel og Epithel; efter Undersøgelse af hele Snitserien er jeg dog overbevist om, at Bindevævet kun ligger som en Omhylning af Muskelenden (som ovenfor i Fig. 26) og ikke som et Mellemlid mellem Muskel og hypodermal Sene. De Muskeltraade, der i dette Snit ikke naa Epithelet, træde nemlig utvivlsomt i et af de følgende i Forbindelse hermed, medens i disse paa den anden Side Bindevævet andetsteds kommer til Syne.

Hermed vil jeg slutte Undersøgelsen af Krebsdyrene; tilbage staar nu kun i Korthed at give en Oversigt over de i det foregaaende fremstillede Resultater.

Oversigt.

Musklerne hos Leddedyrene fæste sig dels til indre, i dette Arbejde kun lidet omtalte Bindevævsmasser, dels til Hudskelettet, der, for at afgive bedre Befæstningspunkter stedvis kan vise sig tapformet fortykket, eller endog være trukket ud til lange, indadrettede, oprindelig hule Forlængelser, de chitiniserede Sener eller Apo-

demata, der i alle Maader forholde sig som det øvrige Chitinskelet. Musklerne Insertion til en Chitinsene og til den almindelige Chitinbeklædning fremtræder ogsaa nøjagtig paa samme Vis: stedse finder man mellem Muskelsubstans og Chitin et særegent Lag, en epithelial Sene, fremkommen ved Omdannelse af det, udfor Muskens Ende liggende Celleparti i den chitindannede Hypodermis.

Hvad der navnlig udmærker disse epitheliale Seneceller og berettiger dem til dette Navn, er de finere eller grovere Længdefibriller, som har uddifferentieret sig i deres Protoplasma, og hvorved de stikke stærkt af mod de omgivende, sædvanlige Epithelceller *). Hvor Forholdene ere tydelige, altsaa navnlig hvor Celleelementerne ere af anseeligere Størrelse, ser man, at Musklen altid ender paa samme Maade, nemlig paa det Sted, hvor en smal, mørk Tværskive vilde have sin Plads. Her ligger nu Epithelets Basalmembran**), der i Regelen lader sig paavise efter passende Farvning, omend den i enkelte Tilfælde synes at være af en saa forsvindende Tykkelse, at den vanskeligt med Sikkerhed iagttages; i sidstnævnte Tilfælde vil man dog næppe kunne tænke paa en direkte Insertion, da det mellem Muskens tværstribede Substans og Chitinen liggende fibrillære Parti fremtræder med en ganske anden Farvetone end Musklen, og desuden Formen af de deri liggende Kerner, eller stundom Tilstedeværelsen af Pigmentkorn, tydeligt nok viser dets Sammenhæng med den øvrige Hypodermis.

Udstrækningen af den fibrillære Omdannelse af Epithelets Celler svarer nøje til Muskens Omfang; er denne bred, er en hel Række Celler, er den derimod smal kun en enkelt Celle, ja, som ovenfor omtalt, stundom kun en lille Del af en saadan seneagtig uddannet; fæste med smaa Mellemrum en Række Muskeltraade sig til Hypodermis, ses i denne en Række indbyrdes adskilte Senepartier.

I de omdannede Epithelpartier ser man ofte ligesom en gruppevis Anordning af Fibrillerne; Grunden hertil er vistnok, at Fibrillerne indenfor de enkelte Celler have sluttet sig nøjere sammen; Cellekernen ligger i saa Fald enten midt i eller paa Siden af disse Fibrilbunder.

Senepartiet svarer som oftest i Højde til den omgivende Hypodermis; ligesom denne kan det indskrænkes til et meget tyndt Lag; i visse Tilfælde er det lidt højere end Omgivelserne, hvorved vi faa en Overgang til de ejendommelige, stærkt

*) Kun i et enkelt Tilfælde, Bagtarmen af en Kakkerlak, er det ikke lykkedes mig at se nogen nævneværdig Omdannelse af den epitheliale Insertionscelle.

**) Om denne iøvrigt, i Overensstemmelse med sit Navn, stedse er dannet fra Epithelcellerne alene, eller om der ogsaa i den indgaa, i større eller mindre Maalestok, Dele af det underliggende Bindevæv, tør jeg ikke med Bestemthed udtale mig om; i Betragtning af den nøje Forbindelse, hvori den ofte staaer til utvivlsomme Bindevævspartier (f. Eks. Fig. 24), hælder jeg dog nærmest til den sidstnævnte Antagelse. Paa Grænsen mellem en Muskel og det tilhørende Seneparti er rimeligvis ogsaa Sarclemmaet optaget i Basalmembranen; i Præparater af Udviklingsstadier af de nævnte Dele ses nemlig Anlæggene til Muskelprimitivbunderne helt rundt omgivne af deres Sarclemma; at dette senere hen synes at standse ved Basalmembranen, skyldes sikkert kun, at det ved Muskens Ende holder sig ganske tyndt og samtidig slutter sig nøje til Basalmembranen, medens det ved Muskens Sider bliver ganske særligt iøjnefaldende derved, at Bindevæv slutter sig tæt til det.

forlængede Senedannelser, der ovenfor ere paaviste hos visse Hvepser, Biller og Fluer. Disse, der vel maa adskilles fra de chitiniserede Apodemata, fremkomme ved en stærk Forlængelse af flere eller færre Epithelceller; Antallet af saadanne kan stundom være meget anseligt, men synker andetsteds betydeligt, hvorved der dannes en Overgang til hine meget langstrakte og tynde, af kun en enkelt Celle dannede Senetraade hos Hvepser og Fluer. Tilstedeværelsen af Kerner viser under alle Omstændigheder disse Dannelsers Opbygning af Celler, og, ligesom Overgangen mellem det uomdannede Epithel og en af en hel Cellegruppe dannet Sene er let at se, saaledes vil man heller ikke forgæves lede efter Overgange fra almindelige hypodermale Seneceller til de stærkt forlængede Senetraade. Senepartiets Højde synes endelig i enkelte Tilfælde at kunne vise sig lidt mindre end Epithelets, hvorved folgelig Muskeltraaden faar Udseende af at gennembore Epithelet; dog naar den kontraktile Substans afgjort ikke ud til Chitinen, og muligvis skyldes det hele, noget afvigende Billede kun den Omstændighed, at Chitinen ligger i Folder, og Epithelet med Undtagelse af Senepartiet som Følge deraf viser sig noget fortykket.

Det indbyrdes Forhold mellem Muskel- og Senefibrillerne maa rimeligvis opfattes saaledes, at begge ligge i hinandens Forlængelse, adskilte ved Basalmembranen; er denne nu ganske tynd, vil man meget let faa Indtrykket af en virkelig Continuitet; en saadan er ganske vist paastaaet af visse Forfattere, men uden at tvingende Grunde dertil ere anførte. Derimod synes det Forhold, at der i Hypodermis kan optræde Fibrilbunder, som utvivlsomt have Betydning for Insertionen af Musklerne, men alligevel ere skilte fra disse ved et svært Bindevævsparti (*Branchipus*) eller Fundet af lignende epitheliale Støttefibriller paa Steder, hvor der overhovedet ikke inserere sig Muskler (Krebsenes Gællefødder), afgørende at vise, at saadanne Fibriller meget vel kunne opstaa selvstændigt i Epithelcellerne. Erindrer man endelig, hvor tydeligt den epitheliale Sene og Musklen ogsaa under deres Udvikling staa mod hinanden, vil man sikkert anse det for den naturligste Antagelse, at Muskel- og Senefibriller kun ligge i hinandens Forlængelse; deres nøje Forbindelse indbyrdes bliver mindre paafaldende, naar man betænker, at Udviklingen af Senefibriller i Epithelet selvfølgelig er betinget af og gaar Haand i Haand med Udviklingen af Muskelfibriller i Vævet indenfor.

Udfor Muskelfæsterne kan Chitinen stundom vise en ejendommelig Farvetone, der utvivlsomt maa skyldes en lille, lokal Afvigelse i dens kemiske Sammensætning; derimod er det intetsteds lykkedes mig at konstatere den stundom omtalte Indtrængen i Chitinen af Senefibrillernes distale Ende; den synes mig iøvrigt, af Hensyn til Hudskiftet, heller ikke let forstaaelig.

Til Slut maa det være mig tilladt at rette en hjertelig Tak til Hr. Dr. phil. R. S. BERGH saavel for den Hjælp, han har ydet mig under mit Arbejde, som for den Interesse, hvormed han stadig har fulgt dettes Fremgang.

Det histologisk-embryologiske Laboratorinm ved Københavns Universitet,

d. 24. Januar 1904.

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† De saaledes betegnede Arbejder have været mig utilgængelige.

Tavleforklaring.

Almengyldige Betegnelser:

<i>A</i>	Apodema	<i>M</i>	Muskulatur
<i>B</i>	Basalmembran	<i>m</i>	Kerner i samme
<i>Bi</i>	Bindevæv	<i>S</i>	Fibrillære, som Sener virkende
<i>C</i>	Chitin		Partier af Hypodermis
<i>H</i>	Hypodermis	<i>Sl</i>	Sarkolemma
<i>L</i>	Vandreceller (Leukoeyter)	<i>T</i>	Afvigende Farvetone i Chitinen

Tavle I.

- Fig. 1. *Lepisma saccharinum* L.; Baghoved. Fire Muskeltraade med de tilhørende, epitheliale Senepartier. $\times 420$.
- Fig. 2. *Lepisma saccharinum* L.; tredje Benpar. Epithelet er her meget lavt med stærkt fladtrykte Kerner. $\times 420$.
- Fig. 3. *Periplaneta americana* L.; Tværsnit af Bagkrop. Den fibrillære Hypodermis viser nalmindelig mange Kerner; en lin Basalmembran ses ved Muskens Ende, hvor en tynd, mørk Skive ellers vilde have sin Plads. $\times 420$.
- Fig. 4. *Periplaneta americana* L.; Tværsnit af Bagkrop. Overgang fra den almindelige Hypodermis til hypodermale Seneceller, der vise sig som udprægede Cylinderceller med langstrakt Kerne og svagt fibrillært Protoplasma. Basalmembranen bliver utydelig udfor Musklen. $\times 420$.
- Fig. 5. *Periplaneta americana* L.; Tværsnit af Bagkrop. Det centrale Parti af det i foregaaende Figur fremstillede Muskelfæste. I hver Epithelcelle, hvis distale Ende ligger lidt indsaenket i Chitinen, samle Fibrillerne sig til en sluttet Masse, udenfor hvilken den langstrakte, smalle Kerne har sin Plads. Nogen tydelig Basalmembran var ej at se. $\times 420$.
- Fig. 6. *Periplaneta americana* L.; Bagtarm. En tynd Muskeltraad fæster sig til en ikke særlig omdannet Epithelcelle. $\times 500$.
- Fig. 7. *Agrion*, Nymfe; Hoved. De hypodermale Seneceller vise Kernerne liggende midt imellem Fibrillerne; en Basalmembran ses tydeligt. $\times 420$.
- Fig. 8. *Agrion*, Nymfe; Basis af Vinge. Anlæg til en Muskel og dens epitheliale Sener. Hypodermis viser sig udfor Muskelanlægget som et tydeligt enlaget Cylinderepithel; forneden synes Uddannelsen af Fibriller begyndt i dette; foroven bærer Chitinen en indadrettet Forkængelse, Begyndelsen til et Apodema. $\times 200$.
- Fig. 9. *Agrion*, Nymfe; Muskelanlæg i Brystet. Grænsen mellem Muskel og Epithel fremtræder meget skarpt, omend langt fra som en ret Linie. $\times 420$.
- Fig. 10. *Bombus*; Bryst. Det fibrillære Epithel med store, Musklen derimod med traadline Kerner. $\times 420$.
- Fig. 11. *Bombus*; Bryst. En Gruppe Muskeltraade fæster sig til en Trachéudvidelse; paa dennes Chitinlag, der næsten ligger i Snittets Plan, ses i et tyndt Protoplasmalag store Kerner (h), der rimeligvis tilhøre uomdannede Epithelceller; desuden strække sig derfra lange, fibrillære Støttepiller (S), hvoraf hver tjener som Sene for et Muskelprimitivbundt, bærer en Kerne tæt op til Fibrilmassen og utvivlsomt maa opfattes som en stærkt forlænget Epithelcelle. $\times 420$.
- Fig. 12. *Formica*, Larve; Kropvæg. Stærkt fremtrædende Fibriller ses i Epithelet udfor Musklernes Ender. $\times 420$.

- Fig. 13. *Formica*, Larve; Undersiden af første Brystring. Muskernes Grene træde ved Hjælp af smalle, fibrillære Partier indenfor Hypodermiscellernes Omraade i Forbindelse med Chitinen. $\times 420$.
- Fig. 14. *Ilybius obscurus* Marsh., Larve; Hovedets Overside. Tre Muskler med deres hypodermale Seneparti. $\times 420$.
- Fig. 15. *Ilybius obscurus* Marsh., Larve; Hovedets Underside. En Muskeltraad tager Fæste ved Hjælp af et Knippe forlængede Hypodermisceller; Overgangen til det sædvanlige Epithel iagttages let. $\times 420$.

Tavle II.

- Fig. 16. *Anthrenus varius* F., Larve; sidste Bagkropsring. Muskels Sene er dannet af talrige forlængede Epithelceller. $\times 420$.
- Fig. 17. *Anthrenus varius* F., Larve; Oversiden af anden Brystring. Saavel Chitin som Hypodermis er stedvis stærkt fortykket; Fibrillerne i hver Epithelcelle have sluttet sig sammen til en Regle, udenfor hvilket Kernen har sin Plads. $\times 420$.
- Fig. 18. *Tipula*, Larve; Kropvæg. Det udfor den brede Muskel liggende epitheliale Seneparti indeholder Kerner. $\times 420$.
- Fig. 19. *Musca vomitoria* L. Det ventrale Fæste af en Flyvemuskel med det kerneholdige, epitheliale Seneparti. $\times 420$.
- Fig. 20. *Tipula*, Larve; Kropvæg. Det smalle Seneparti indeholder ingen Kerner. I Chitinen ses udfor Senen en ejendommelig, mørkere farvet Skygge (T). $\times 420$.
- Fig. 21. *Musca vomitoria* L.; det dorsale Fæste af et Knippe Flyvemuskler. For hvert Muskelprimitiv-bundt findes en traadformet forlænget og i sin proksimale Ende kegleformet udvidet Sene-dannelse (S); denne, der ved smaa Foldninger af Snittet enkelte Steder er bleven lidt uregelmæssigt bøjet, viser sig sammensat af fine Fibriller, bærer paa sin Overflade en tydelig Kerne og maa utvivlsomt opfattes som en stærkt forlænget Epithelcelle. I Figuren ses desuden et Par langt mindre omdannede epitheliale Seneceller (S_1). $\times 420$.
- Fig. 22. *Sarcophaga carnaria* L.; Tværsnit gennem den bageste Del af Æggelederen (Skeden). En tæt under Hypodermis løbende Ringmuskeltraad er ved fine, fibrillære Forbindelsestraade (F) fra Epithelcellerne i Forbindelse med denne. $\times 750$.
- Fig. 23. *Branchipus Grubii* Düb.; Undersiden af Hovedet. Til de meget uensartet kontraherede Grupper af Muskeltraade slutter sig i Epithelet tilsvarende Grupper af fine Fibriller; en fin og ujævn, men tydelig Basalmembran ses. $\times 420$.
- Fig. 24. *Branchipus Grubii* Düb.; Oversiden af Hovedet. Epithelet, der lidt efter lidt tiltager i Højde, indeholder Knipper af Støttefibriller (S); Basalmembranen gaar over i et svært Bindevævs-parti (Bi), hvortil saavel Musklerne som Fibrillerne i Epithelet fæste sig. $\times 420$.
- Fig. 25. *Balanus improvisus* Don.; Kropfod. En skarp Grænse mellem Muskeltraad og den fibrillære, med Pigmentkorn fyldte Hypodermis er ikke synlig. $\times 420$.
- Fig. 26. *Asellus aquaticus* L.; Kropvæg. Muskeltraad med dens epitheliale, kerneholdige Seneparti. I Epithelet saavel som i Bindevævet under dette og omkring Muskels Ende ses talrige Pigmentkorn. $\times 420$.
- Fig. 27. *Asellus aquaticus* L.; Sidevæggen af Svælget. Musklerne sænke sig, medtagende Basalmembranen, et lille Stykke ned i Epithelet, men Insertionen paa Chitinen sker ved et kun længdestribet, epitheliale Seneparti. $\times 420$.
- Fig. 28. *Astacus fluviatilis* L.; Endetarmens bageste Del. Muskels Grene naa til Epithelets Grænse; deres Insertion sker ved epitheliale Fibriller. $\times 375$.
- Fig. 29. *Astacus fluviatilis* L.; Kindbakkemuskel. Epithel og Muskel skilte ved en tynd Basalmembran; længst til højre ses noget Bindevæv (Bi), som omhyller Muskels Ende, men dog næppe spiller nogen betydeligere Rolle ved dennes Insertion. $\times 375$.

RÉSUMÉ.

L'insertion des muscles sur le squelette chitineux des animaux articulés.

Par

R.-H. STAMM.

Si l'on essaye, d'après les données histologiques fournies par les travaux antérieurs, de se faire une idée de la manière dont les muscles des animaux articulés s'insèrent sur le squelette chitineux, on constate que la chose est assez malaisée, car les informations publiées sur ce sujet et dispersées dans différents ouvrages, sont très loin de s'accorder entre elles. Il résulte de l'exposé donné plus haut (p. 3-11) de la bibliographie de cette question, que nous nous trouvons toujours en présence de deux opinions antagonistes. Tout un groupe de savants tels que MM. HAECKEL, BAUR, BRAUN, LEYDIG, BERTEAU, JANET, DUBOSCQ — et, jusqu'à un certain point, M. N. HOLMGREN — maintiennent l'existence d'un épithélium séparant le muscle de la chitine; MM. BRAUN et BERTEAU ont même démontré les premiers la structure fibrillaire du dit épithélium. Par contre, il y a des auteurs, et non seulement d'anciens auteurs, auxquels la structure de l'apodème chitineux n'était pas connue, mais des savants très modernes comme MM. ANT, SCHNEIDER, IDE, SADONES, PANTEL, SCHÖNICHEN, HECHT et, en partie, M. N. HOLMGREN, pour qui les muscles s'insèrent directement sur la chitine. Remarquons toutefois qu'à l'exception de M. SCHÖNICHEN, tous les auteurs qui partagent cette théorie affirment que l'extrémité distale du muscle a perdu sa striation transversale et qu'elle a pris un caractère tendineux, étant composée exclusivement de fibrilles longitudinales. Qu'il y ait d'ailleurs des discordances de détail entre les auteurs appartenant à l'un ou l'autre de ces deux groupes, c'est à quoi on devait s'attendre vu la diversité des objets étudiés et les intervalles considérables qui séparent les différentes publications.

Dans ce qui suit, je tâcherai de donner un exposé sommaire du résultat de mes recherches personnelles.

Le squelette chitineux présente quelquefois, dans les endroits où s'insèrent les muscles, un épaissement plus ou moins considérable. Il arrive même que dans une telle partie épaissie la surface extérieure de la chitine s'enfonce et forme une espèce d'entonnoir ou de prolongement dirigé en dedans et originairement creux. Ces prolongements ou apodèmes se comportent en tout comme le reste du squelette chitineux. Aussi l'insertion du muscle se fait-elle toujours de la même manière soit qu'elle ait lieu sur un apodème soit que le muscle s'attache sur le revêtement chitineux lui-même; nous trouvons toujours entre la substance musculaire et la chitine une couche particulière: un tendon épithélial qui n'est en réalité qu'un état modifié de la partie cellulaire située à l'extrémité du muscle, dans l'hypoderme chitino-gène. Les cellules du tendon épithélial doivent leur caractère tendineux aux fibrilles longitudinales de grosseur variable qui se sont développées par différenciation dans leur protoplasma (fig. 3, 5, 7, 14) et qui les distinguent nettement des cellules épithéliales ordinaires qui les entourent (fig. 1, 4, 7, 26¹⁾). Dans les cas d'observation facile, et notamment dans ceux

¹⁾ Dans un seul cas où l'objet examiné était l'intestin terminal d'une Blatte (fig. 6) je n'ai pu constater qu'une très faible modification dans la cellule d'insertion épithéliale.

où les éléments cellulaires sont de dimensions considérables, on voit que le muscle se termine toujours de même, c'est-à-dire à un endroit où on s'attendrait à trouver un disque mince (fig. 3, 14, 19, 26). C'est ici que se découvre la membrane basale¹⁾ de l'épithélium; le plus souvent on parvient à la faire paraître moyennant une teinture convenable (fig. 3, 7, 26), mais il arrive aussi qu'elle est d'une épaisseur tellement minime qu'on a de la difficulté à en constater la présence (fig. 5, 18, 25). Toutefois, même lorsqu'il en est ainsi, on peut difficilement croire à une insertion directe, la partie fibrillaire interposée entre la substance transversalement striée du muscle et la couche chitineuse offrant une coloration absolument différente de celle du muscle, et la connexité entre cette partie fibrillaire et l'hypoderme proprement dit étant d'ailleurs attestée par la forme des noyaux renfermés dans celle-là ou par la présence, dans cette partie, de granulations pigmentaires (fig. 25). La modification fibrillaire des cellules épithéliales a toujours une étendue exactement proportionnée à la taille du muscle; si ce dernier est large, elle comprendra toute une série de cellules (fig. 3, 5, 10, 18); s'il est mince, elle affectera une seule cellule; il y a même des cas où il semble qu'une faible partie seulement d'une telle cellule a pris ce caractère tendineux (fig. 13, 27, 28). Là où nous avons une série de fibres musculaires insérées sur l'hypoderme à de petits intervalles, nous voyons y correspondre une série de parties tendineuses séparées par des parties d'hypoderme non modifiées (fig. 1, 13, 23, 27). Dans les parties épithéliales qui présentent cette transformation, on observe souvent que les fibrilles sont disposées par groupes (fig. 5, 7, 17, 29); la raison en est probablement que les fibrilles de chaque cellule se sont réunies en un faisceau. Quant au noyau cellulaire, il est alors situé soit au milieu de ces faisceaux de fibrilles (fig. 7), soit à côté (fig. 5, 17, 29). Dans la majorité des cas la partie tendineuse a la même épaisseur (quelquefois très faible, voir fig. 2) que l'hypoderme qui l'entoure; si elle devient plus épaisse nous nous trouvons en présence d'une transition vers les formations tendineuses très allongées qu'on a constatées chez certains Hyménoptères (fig. 11), Coléoptères (fig. 15, 16, 17) et Diptères (fig. 21). Ces prolongements, qu'il ne faut pas confondre avec les apodèmes chitinisés, se composent de cellules épithéliales très allongées. Le nombre de ces cellules peut monter à un chiffre très élevé (fig. 16, 17); d'autre part il y a des cas où il est extrêmement faible (fig. 15) et dans ceux des Hyménoptères (fig. 11) et des Diptères (fig. 21) nous avons affaire à des fibres tendineuses formées d'une seule cellule. En tous cas l'origine cellulaire de ces formations est attestée par la présence de noyaux, et de même qu'il est aisé de reconnaître le passage de l'épithélium non modifié au tendon constitué par tout un groupe de cellules, il n'est pas non plus difficile de constater des stades intermédiaires entre les cellules d'insertion hypodermiques ordinaires et les fibres tendineuses fortement allongées (fig. 21 S₁).

Enfin il y a des cas isolés où la partie tendineuse a l'air d'être un peu moins épaisse que l'épithélium et où par conséquent la fibre musculaire semble traverser la couche épithéliale (fig. 27). Toutefois la substance musculaire n'arrive certainement jamais en contact immédiat avec la chitine et il se peut que l'apparence quelque peu insolite qu'offre par

¹⁾ De la continuité qui existe souvent entre la membrane basale et des régions incontestablement conjonctives il nous semble permis de conclure que cette membrane se constitue en partie de tissu conjonctif sous-hypodermique, ou du moins que tel doit être le cas toutes les fois qu'elle atteint une épaisseur considérable (fig. 24). Notons encore qu'à la limite qui sépare le muscle de ses cellules d'insertion, le sarcolemme semble intimement uni à la membrane basale. Les échantillons représentant des stades de développement peu avancé (fig. 9) plaident en faveur de cette hypothèse: on y observe des faisceaux musculaires entièrement enveloppés de leur sarcolemme, tandis que dans des spécimens plus développés le sarcolemme se termine apparemment au niveau de la membrane basale, sur le côté du muscle.

exemple la figure 27 soit due seulement à ce fait que dans les endroits en question la chitine présente des plis, par où l'épithélium prend un aspect épaissi. A ce sujet je voudrais attirer l'attention sur quelques autres cas (fig. 12, 13, 20, 28) où l'on pourrait être tenté de se ranger à l'avis de certains auteurs qui allèguent, en faveur de leur hypothèse d'une insertion directe, l'absence complète de noyaux dans la partie tendineuse. Je ferai remarquer d'abord que la substance contractile n'est jamais immédiatement contiguë à la chitine, le muscle s'insérant, tout comme dans les autres cas, sur le squelette chitineux au moyen d'une partie composée de fibrilles longitudinales; ensuite on pourrait objecter le grand nombre d'analogies que présentent ces cas avec ceux dont nous avons parlé plus haut (comparer la fig. 20 avec la fig. 18); enfin les noyaux peuvent très bien être placés au dehors du faisceau fibrillaire (voir ce qui a été dit plus haut). Selon nous, l'aspect aberrant des insertions musculaires dont il s'agit ici, s'explique si nous admettons qu'en raison de la faible largeur des muscles une petite partie seulement d'une cellule épithéliale a été transformée en fibrilles, et je citerai à l'appui de cette hypothèse d'une transformation partielle le fait que la différenciation du protoplasma des cellules tendineuses hypodermiques n'est jamais complète: il reste toujours, outre le noyau, une portion finement réticulée de protoplasma non différencié. Je considère comme beaucoup moins vraisemblable cette autre hypothèse qui, en admettant une insertion du muscle sur la chitine, doit nécessairement admettre aussi une transformation particulière de l'extrémité du muscle en région tendineuse et, chose encore moins croyable, chitinogène¹⁾.

Il n'y a probablement entre les fibrilles musculaires et les fibrilles tendineuses qu'un rapport de contiguïté: les deux espèces de fibrilles sont disposées dans le prolongement l'une de l'autre; elles ne sont séparées que par la membrane basale, et si cette dernière est très mince, on pourra facilement croire à un passage ininterrompu de l'une à l'autre. En effet un certain nombre d'auteurs se sont faits les défenseurs de cette théorie de la continuité, mais les raisons qu'ils ont alléguées ne sont pas convaincantes. D'un autre côté il y a des faits qui semblent plaider en faveur d'une naissance spontanée de fibrilles dans les cellules épithéliales; citons par exemple la présence, dans l'hypoderme, de faisceaux qui jouent certainement quelque rôle dans l'insertion des muscles, tout séparés qu'ils en sont par une épaisse couche de tissu conjonctif (*Branchipus*)²⁾; on pourrait aussi faire valoir l'apparition

¹⁾ M. N. HOLMGREN a donné dernièrement un exposé d'un mode d'insertion des muscles chez les animaux articulés. Suivant lui les muscles présenteraient des ramifications terminales qui s'introduisant parmi les cellules de l'épithélium arriveraient ainsi à s'insérer directement sur la chitine. Il m'a été impossible de retrouver moi-même rien qui correspondit exactement à la figure donnée par M. H. Je me demande si ce ne sont pas les curieuses anastomoses par lesquelles les cellules de l'hypoderme communiquent avec les fibres musculaires à striation transversale (fig. 22), qui ont été l'objet d'une interprétation fautive. Les anastomoses en question ont une structure vaguement fibrillaire; elles s'attachent sur le muscle exactement au niveau d'un disque mince et sombre; cependant il ne faut pas les confondre avec les insertions musculaires proprement dites: elles ont sans doute pour destination de rapprocher le muscle de l'épithélium aux moments où se produisent les contractions du muscle et aussi d'empêcher que la couche de chitine ne forme alors un seul pli continu.

²⁾ Suivant nous c'est dans le protoplasma de l'épithélium augmentant peu à peu en épaisseur que naissent ces faisceaux de fibrilles de soutènement (fig. 24). Après coloration par la fuchsine acide mêlée à l'acide picrique ils prennent une teinte jaune et on les voit s'insérer d'une extrémité sur la chitine, de l'autre sur de très courts prolongements de ce tissu conjonctif, fort puissant par endroits, qui remplace la membrane basale au-dessous de l'épithélium et dont la teinte devient d'un rouge vif lorsqu'on lui fait subir la même coloration. Quant à l'existence d'espaces lymphatiques qu'on a cru pouvoir constater dans l'hypoderme entre les faisceaux fibrillaires de soutènement, je la regarde comme très douteuse; il est vrai qu'on y observe souvent des cellules migratrices, mais cela ne prouve rien, cette sorte de cellules pouvant très bien apparaître dans des parties épithéliales minces de l'animal en question.

de semblables fibrilles de soutènement épithéliales en des endroits dépourvus d'insertions musculaires (branchies de certains Crustacés). Si on tient compte, enfin, de la différence très marquée qui s'accuse déjà pendant leur période de développement, entre le tendon épithélial et le muscle (fig. 8, 9), on sera certainement amené à considérer comme plus probable la théorie d'après laquelle les fibrilles musculaires et les fibrilles tendineuses se trouvent simplement disposées bout à bout, de sorte qu'il y a entre elles contiguïté et non continuité. Le rapport intime qui existe incontestablement entre ces deux espèces de fibrilles devient moins difficile à expliquer dès qu'on se rappelle la dépendance étroite qui relie le développement de fibrilles tendineuses dans l'épithélium à celui des fibrilles musculaires dans le tissu sous-jacent.

Aux endroits où ont lieu les insertions des muscles, la chitine présente quelquefois une nuance particulière qui est due sans doute à une déviation locale de sa constitution chimique. Quant à la pénétration dans la chitine du bout distal des fibrilles tendineuses, phénomène qu'on voit quelquefois noté par les auteurs, je n'ai jamais pu la constater; elle me semble d'ailleurs difficilement conciliable avec la mue des animaux en question.

Explication des Planches.

Liste des Abréviations:

<i>A</i> apodème	<i>M</i> musculature
<i>B</i> membrane basale	<i>m</i> noyaux musculaires
<i>Bi</i> tissu conjonctif	<i>S</i> partie tendineuse de l'hypoderme
<i>C</i> chitine	<i>Sl</i> sarcosome
<i>H</i> hypoderme	<i>T</i> nuance aberrante de la chitine
<i>L</i> cellules migratrices (leucocytes)	

Planche I.

- Fig. 1. *Lepisma saccharinum* L.; partie postérieure de la tête. Quatre fibres musculaires avec les parties tendineuses épithéliales. ^{420/1}.
- Fig. 2. Id.; troisième paire de pattes. Épithélium très mince, à noyaux fortement aplatis. ^{420/1}.
- Fig. 3. *Periplaneta americana* L.; coupe transversale de l'abdomen. Hypoderme à noyaux très nombreux; membrane basale mince remplaçant, à l'extrémité du muscle, un disque mince. ^{420/1}.
- Fig. 4. Id.; coupe transversale de l'abdomen présentant le passage de l'hypoderme proprement dit aux cellules tendineuses hypodermiques de forme nettement cylindrique, à noyau allongé, à protoplasma faiblement fibrillaire. Entre ces dernières et le muscle la membrane basale ne se voit qu'indistinctement. ^{420/1}.
- Fig. 5. Id.; coupe transversale de l'abdomen où s'observe la partie centrale de l'attache musculaire représentée dans la figure précédente. Toutes les cellules épithéliales ont leurs extrémités distales un peu enfoncées dans la chitine et les fibrilles forment dans chaque cellule une masse distincte à côté de laquelle est situé le noyau allongé et mince. La membrane basale n'apparaît pas. ^{420/1}.
- Fig. 6. Id.; intestin terminal. Attache d'une mince fibre musculaire sur une cellule épithéliale peu modifiée. ^{500/1}.
- Fig. 7. *Agrion*, nymphe; tête. Les cellules tendineuses épithéliales ont leurs noyaux disposés au milieu du faisceau fibrillaire. Une membrane basale se voit distinctement. ^{420/1}.
- Fig. 8. Id.; base d'aile. On y voit un muscle à l'état d'ébauche avec tendons épithéliaux. Les parties de l'hypoderme qui avoisinent le muscle ébauché constituent une couche épithéliale simple à cellules cylindriques; cette couche semble renfermer, en bas, des fibrilles à l'état naissant. En haut s'observe, sur la chitine, un procès dirigé en dedans, commencement d'un apodème. ^{200/1}.
- Fig. 9. Id.; muscle thoracique ébauché. La limite qui sépare le muscle de l'épithélium est très distincte; toutefois elle n'apparaît pas comme une ligne droite. ^{420/1}.
- Fig. 10. *Bombus*; thorax. Les noyaux de l'épithélium fibrillaire ont des dimensions considérables, ceux du muscle au contraire sont extrêmement minces, presque filiformes. ^{420/1}.

- Fig. 11. Id.; thorax. Un groupe de fibres musculaires se trouve inséré sur un renflement de trachée. Sur la couche chitineuse dont la surface coïncide à peu près avec le plan de la coupe, se voient, dans une mince couche protoplasmique, quelques grands noyaux (h) appartenant probablement à des cellules épithéliales non modifiées; de plus on voit partir de là des prolongements fibrillaires (S) dont chacun sert de tendon à un faisceau primitif de muscles et présente un noyau disposé tout contre la masse fibrillaire. Ce sont là sans doute des cellules épithéliales très allongées. ^{420/1.}
- Fig. 12. *Formica*, larve; paroi abdominale. Des fibrilles fortement développées s'observent dans l'épithélium qui borde l'extrémité des fibres musculaires. ^{420/1.}
- Fig. 13. Id.; paroi ventrale du premier segment thoracique. Les arborisations terminales des muscles communiquent avec la chitine à l'aide de minces parties fibrillaires disposées dans les cellules de l'hypoderme. ^{420/1.}
- Fig. 14. *Ilybius obscurus* Marsh., larve; partie supérieure de la tête. Trois muscles avec les cellules tendineuses hypodermiques. ^{420/1.}
- Fig. 15. Id., larve; partie inférieure de la tête. Une fibre musculaire s'insère à l'aide d'un faisceau de cellules hypodermiques allongées; le passage à l'épithélium proprement dit est facile à reconnaître. ^{420/1.}

Planche II.

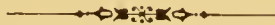
- Fig. 16. *Anthrenus varius* F., larve; dernier segment abdominal. Le tendon du muscle se compose de nombreuses cellules épithéliales allongées. ^{420/1.}
- Fig. 17. Id.; partie supérieure du deuxième segment thoracique. La couche chitineuse aussi bien que l'hypoderme présente des épaississements remarquables. Les fibrilles de chaque cellule épithéliale forment un faisceau à côté duquel est situé le noyau. ^{420/1.}
- Fig. 18. *Tipula*, larve; paroi abdominale. La région tendineuse épithéliale renferme des noyaux. ^{420/1.}
- Fig. 19. *Musca vomitoria* L.; insertion ventrale d'un muscle de l'aile; la partie tendineuse épithéliale présente un noyau. ^{420/1.}
- Fig. 20. *Tipula*, larve; paroi abdominale; partie tendineuse mince et dépourvue de noyaux. La couche chitineuse présente dans le prolongement du tendon une région de nuance plus foncée que le reste (T). ^{420/1.}
- Fig. 21. *Musca vomitoria* L.; insertion dorsale d'un faisceau de muscles de l'aile. A chaque faisceau musculaire primitif correspond un prolongement tendineux filiforme qui présente à son extrémité proximale un renflement conique (S). L'aspect un peu contourné des prolongements représentés dans cette figure est dû aux difficultés qu'offrirait la disposition de la coupe sur une surface plane. Ces prolongements, qui se composent de fibrilles extrêmement minces, ont chacun un noyau périphérique distinct; ce sont sans doute originellement des cellules épithéliales très allongées. Dans la même figure se trouvent en outre représentées quelques cellules tendineuses épithéliales (S₁) dont la transformation est beaucoup moins avancée. ^{420/1.}
- Fig. 22. *Sarcophaga carnaria* L.; coupe transversale de la partie postérieure de l'oviducte (vagin). Une fibre de muscle circulaire, située à peu de distance de l'hypoderme, communique avec celui-ci par de fines anastomoses (F) qui partent des cellules épithéliales. ^{750/1.}
- Fig. 23. *Branchipus Grubii* Düb.; paroi ventrale de la tête. Aux groupes de fibres musculaires très inégalement contractées correspondent, dans l'épithélium, des groupes de fines fibrilles; une membrane basale, mince et d'allure irrégulière apparaît distinctement. ^{420/1.}
- Fig. 24. Id.; partie supérieure de la tête. L'épithélium, qui augmente ici peu à peu d'épaisseur, renferme des faisceaux de fibrilles de soutènement (S); la membrane basale est continuée par une épaisse couche de tissu conjonctif (Bi) où s'insèrent les muscles aussi bien que les fibrilles épithéliales. ^{420/1.}
- Fig. 25. *Balanus improvisus* Don.; patte abdominale. La fibre musculaire ne se distingue de l'hypoderme que par l'absence de grains pigmentaires. ^{420/1.}
- Fig. 26. *Asellus aquaticus* L.; paroi abdominale. Fibre musculaire avec la partie tendineuse épithéliale, qui renferme des noyaux. Les granulations pigmentaires sont nombreuses dans l'épithélium ainsi que dans le tissu conjonctif sous-jacent et autour de l'extrémité du muscle. ^{420/1.}
- Fig. 27. Id.; paroi de l'œsophage. Les muscles, aussi bien que la membrane basale, s'enfoncent un peu dans l'épithélium tandis que sur la chitine l'insertion a lieu par l'intermédiaire d'une partie tendineuse épithéliale striée en long. ^{420/1.}
- Fig. 28. *Astacus fluviatilis* L.; partie postérieure du rectum. Les arborisations musculaires atteignent la limite de l'épithélium; elles s'insèrent par des fibrilles épithéliales. ^{375/1.}
- Fig. 29. Id.; muscle de la mandibule. L'épithélium et le muscle se trouvent séparés par une mince membrane basale. Tout à fait à droite se voit un peu de tissu conjonctif (Bi) qui enveloppe l'extrémité du muscle, mais n'a guère d'importance pour son insertion. ^{375/1.}





UNDERSØGELSER
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BIANCO LUNOS BOGTRYKKERI

1904

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	Side
Indledning	169 (5)
Om Dobbeltringe og falsk Aarringsdannelse	170 (6)
Undertallige Aarringe	180 (16)
Ufuldstændige, ntydelige og sammensmeltede Aarringe	185 (21)
Aarringsbredde og Vedkvalitet, Naboringe	190 (26)
Aarringsbredde og Vedkvalitet, andre Tilfælde	200 (36)
Karvidde og Aarringsbredde	210 (46)

Lige som Træernes Aarringsdannelse i sin Helhed endnu staar som et i viden- skabelig Forstand ikke forklaret Fænomen, for saa vidt som man ikke med Sikker- hed kan gøre Rede for, hvad der bevirker de særegne Bygningsforhold, hvorpaa Dannelsen af en iagttagelig Aarringsgrænse beror, saaledes frembyder den ogsaa forskellige enkelte Problemer, hvis Behandling har givet Botanikerne adskilligt at bestille og givet Anledning til megen Meningsforskel. Enkelte Spørgsmaal er blevne belyst ad experimentel Vej, f. Eks. Dannelsen af Bælter af trykfast Ved, men denne Maade at iagttage paa er for Træernes Vedkommende noget omstændeligere end for de urteagtige Planter; de fleste iagttagelser er derfor gjort som direkte Under- søgelser og Resultaterne ofte frembragte paa Grundlag af et stort Tal-Materiale, hvilket i mange Tilfælde kan gøre Publikationerne over disse Emner mindre til- talende at læse. Der er vel ingen af dem, der har arbejdet paa dette Felt, der har havt saa stort og saa godt et Materiale til sin Raadighed som ROBERT HARTIG, og der er heller neppe nogen, der har arbejdet med den Energi og tumlet med saa mange Opgaver som han har. Han har mulig arbejdet med for stor Selvtillid og maaske ogsaa derved selv bidraget til at ægge til Opposition, men hans talrige Ar- bejder til Belysning af Træernes, særlig Veddets Naturhistorie, vil i lang Tid blive at anføre som de væsentligste Litteraturkilder til Studiet af disse Forhold, hvortil ogsaa som et væsentligt Moment kommer den levende Interesse for og Kærlighed til disse Undersøgelser, som han stadig lægger for Dagen. Hartig døde, medens han endnu havde Hænderne fulde af Arbejde, og ogsaa af den Grund for tidligt, fordi han netop var i Gang med at forlade et i theoretisk Henseende i visse Maader mindre heldigt Standpunkt og tiltræde det af yngre Forskere paa dette Omraade — Frank Schwarz, Metzger og andre — hævdede Synspunkt, i Følge hvilket Op- fattelsen af Forholdet mellem Ernæringsvirksomheden og Væksten er bleven en væsentlig anden end den var før.

Men bortset fra de mere kapitale Spørgsmaal, f. Eks. om Aarsagerne, der ligger til Grund for, at Væksten sker paa den eller den Maade, er der med Hensyn til Veddets mange Bygningsforhold, som trænger til Belysning, Modsigelser, der kun kan hæves ved fortsatte iagttagelser og som tildels er fremkomne, fordi de enkelte Spørgsmaal ikke er redede tilstrækkelig ud fra hverandre, Generalisationer, der ikke

er berettigede, fordi de er byggede paa et utilstrækkeligt Antal Kendsgerninger o. s. v., og jeg kan egentlig slutte mig til følgende Udtalelse af en fransk forstbotanisk Forfatter¹⁾: Peut-être n'est il pas temps encore, vu l'état de la science, de chercher à tout prix des explications physiologiques: peut-être convient-il auparavant de poursuivre les investigations portant sur les faits mêmes et de compléter l'inventaire des observations et des constatations.

I det følgende vil jeg tage nogle enkelte Spørgsmaal op af de mange, der frembyder sig ved Undersøgelsen af Aarringenes Bygning og Udvikling, men Behandlingen af dem vil blive noget uensartet, idet nogle vil blive behandlede mere indgaaende, andre snarere blot strejfede eller betragtede mere fra den historiske Side.

Om Dobbelttringe og falsk Aarringsdannelse.

I en tidligere Afhandling²⁾, Nogle Bemærkninger om abnorme Løvforholds Indflydelse paa Aarringsdannelsen», er jeg kommen til det Resultat, der er udtalt i følgende Sætning: Jeg maa saaledes anse Dannelsen af skarpt markerede Dobbelttringe som Følge af dobbelt Beløvning, hvad enten denne finder Sted efter forudgaaende Allovning eller ikke, for meget sjælden» (S. 427). Jeg skal nu i det følgende komme lidt nærmere ind paa Spørgsmaalet om dobbelt eller falsk Aarringsdannelse og til en Begyndelse omtale, hvad jeg siden da har modt i Litteraturen angaaende denne Sag, idet jeg iøvrigt henviser til, hvad jeg i den nævnte Afhandling har fremdraget.

Omtrent samtidig med at de ovennævnte lagttagelser blev publicerede modtog jeg fra Amerika en Afhandling med Titel: The Trees of St. Louis as Influenced by the Tornado of 1896³⁾ af H. von SCHRENK. Den 27 Maj 1896 anrettede en Tornado i den sydlige Del af St. Louis stor Ødelæggelse paa Træerne sammesteds, der var saa meget mere følelig som Løvet netop stod i sin fulde friske Udvikling. Hvor de unge Kviste var brudte af, indfandt der sig mange Steder under det paafølgende varme og regnfulde Vejr en ny Løvklædning. Virkningen heraf paa Aarringsdannelsen blev undersøgt det paafølgende Aar, og det lykkedes Schrenk at paavise en Afbrydelse i den normale Vedudvikling for 1896, der, forudsat at ingen Fejlbestemmelse har fundet Sted, virkelig ikke er til at skelne fra en virkelig Aarringsgrænse. Disse Undersøgelser blev gjort paa *Platanus occidentalis* og *Acer dasycarpum*, og Afbildningen Tavle V af Platanen er navnlig meget oplysende i denne Henseende.

Ved atter at gaa RATZEBURGS Waldverderbniss⁴⁾ igennem er jeg bleven opmærksom paa et Par Steder, som jeg maa omtale her. I 2det Bind findes der Tavle 48 Fig. 9

¹⁾ E. GUINIER. La qualité du bois dans ses rapports avec la rapidité de la végétation et l'épaisseur des couches annuelles d'accroissement (Revue des eaux et forêts 1889, S. 250).

²⁾ Oversigt over det Kgl. D. Vid. Selsk.'s Forhandlinger 1896.

³⁾ Contributions from the Shaw School of Botany Nr. 10 (Trans. Acad. Sci. of St. Louis, Vol. VIII, Nr. 2).

⁴⁾ J. T. C. RATZEBURG: Die Waldverderbniss 1866—68.

en Afbildning af den sidst dannede Aarring af en *Salix fragilis* med Forklaring S. 451—452; denne betegnes som en Dohbeltring og viser ogsaa en skarp Grænselinie — paa Billedet, men dette gør et skematiseret Indtryk og er derfor ikke fuldt overbevisende; umiddelbart udenfor denne falske Aarringsgrænse findes en Tipulagang; vi har vel her med Marvpletter at gøre. Det maa bemærkes, at Ratzeburgs lagttagelser er i dette Værk saa yderlig slet redigerede, at de af den Grund er vanskelige at benytte. Dette gælder ogsaa Tab. 25 Fig. 10 og 11 i 1ste Bind med tilhørende Forklaring. Her fremstilles en Aarring af *Picea excelsa*, der tydelig er delt i 3 Lag, hvilket er anskueliggjort ved et histologisk Billede. Hvis Billedet og Tydningen er fuldstændig korrekt, foreligger her ganske vist et Eksempel paa, at et Aars Vedlag fremtræder som 3, der fuldstændig gør Indtryk af selvstændige Aarringe. Men korrekt er det histologiske Billede ikke. Thi i dette inderste, bredeste, af de 3 Lag lindes der i det svagt forstørrede Billede Fig. 11 noget indenfor Lagets Midte en ringformet Anomali i Bygningen, som aldeles ikke er bragt til Udtryk i det histologiske Billede Fig. 10. Og er der Unøjagtighed i det ene, kan der ogsaa være i det andet¹⁾.

Jeg gaar derefter over til at omtale nogle af de Bygningsanomalier, der fremtræder som ringformet Struktur imellem Aarringsgrænserne og derved, for saa vidt de er tilstrækkelig tydelig markerede, kan give Anledning til Fejltælling af Aarringe.

Ikke sjældent træffer man hos Træer, i hvis Ved en cirkulær Gruppering af Karrene ellers ikke hører hjemme, en saadan Tilbøjelighed mer eller mindre tydelig udtrykt. I Fig. 1 ses saaledes Aarringen for 1899 af en ung Bøg, og i Grupperingen af Karrene i denne vil man uden Vanskelighed blive en Rhythme var, idet Karrene 6 Gange synes at have udviklet sig i større Mængde med mellemliggende mere karfattige Partier. Dette Tilfælde vilde nu ikke give Anledning til nogen Misforstaaelse, men blev Modsætningen stærkere fremtrædende, kunde det godt føre til en Fejltælling. Opmærksomheden kan maaske ogsaa her henledes paa de Tilfælde, hvor Veddet i sin Bygning har reageret paa Dannelsen af Sommerskud uden

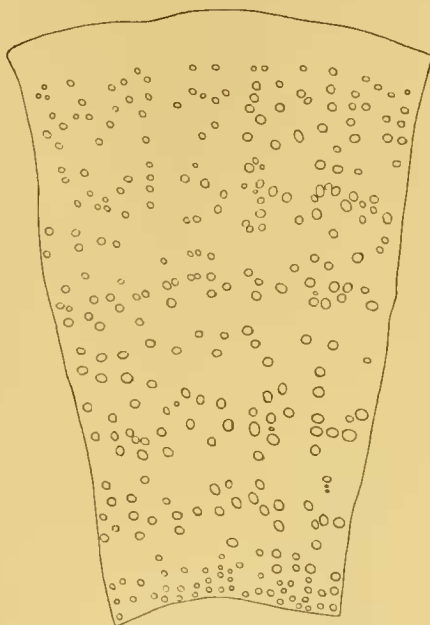


Fig. 1. *Fagus silvatica*²⁾. 48 Gange forstørret.

¹⁾ Et Tilfælde af falsk Aarringsdannelse hos en Bøg er i sine større Træk beskrevet, men ikke histologisk belyst, af NÖRDLINGEN; det er ført tilbage til Angreb af Oldenborrer (PFEIL, Kritische Blätter für Forst- und Jagdwissenschaft, 47de Bd., 2det Hefte S. 78—79, 1865).

²⁾ Forklaringen til Figuren findes gennemgaaende i Teksten.

forudgaaende Aflovning eller Beskadigelse af Løvet, hvorpaa jeg har fremdraget nogle Eksempler i min ovennævnte Afhandling, nemlig *Zelkova* og *Quercus*¹⁾. Ved meget kraftig Udvikling af Sommerskud kan der dog ogsaa undertiden paa anden Maade fremkomme noget, der kan minde om en Aarringsgrænse. I en Bøgehæk fandtes et Aarsskud, hvor Majskuddet var 170 og Sommerskuddet 390 mm. langt, i Majskuddet optraadte der en omtrent halvkredsformet Linje, der godt i en snever Vending kunde tages for en Aarring. Undersøgelsen viste, at den bestod af en

Smule stivelsefyldt Parenkym, der under Mikroskopet aldeles ingen Lighed havde med en Aarringsgrænse²⁾.

Hos Naaletræerne forekommer det ovenfor hos Bog omtalte og afbildede Forhold nok saa karakteristisk. Et ret ejendommeligt Tilfælde har jeg f. Eks. truffet hos en *Pseudotsuga Douglasii* i Landbohøjskolens Have. Fig. 2 viser Aarringen fra 1900 af en seksaargig Gren; denne var stærkt hypotrofisk, og Billedet er fra den underste, brede Del af Aarringen, hvor Veddet havde udviklet sig som Rødved. Det vil ikke være vanskeligt her at erkende 8 Lag, nemlig 4 Lag dannede af mere tyndvæggede og 4 bestaaende af mere tykvæggede Trakeider, gennemgaaende uden skarp Overgang fra det ene Lag til det andet. Denne ejendommelige Bygning strakte sig dog ikke over hele Aarringens Underside, og paa den smalle opadvendte Del af Aarringen var Bygningen normal. Saadanne Fænomener, som man ret jævnlig træffer paa, om end sjældent saa hyppig gentaget i samme Aargang Ved som her, kan, naar de er stærkt markerede, give Anledning til Fejltagelse, og der er ogsaa tidligere gjort opmærksom paa dem, f. Eks. af LUTZ³⁾; vi har vel her med Dannelser at gøre, der svarer til det, som FRANK SCHWARZ⁴⁾ betegner som «Druckzonen».

En lignende lagttagelse er gjort af STRASBURGER⁵⁾, der paa en med det Presslerske Tilvækstbør taget Prop af en kraftig 20aarig Lærk iagttog, at tyndvæggede vide og tykvæggede snevre Trakeider vekslede

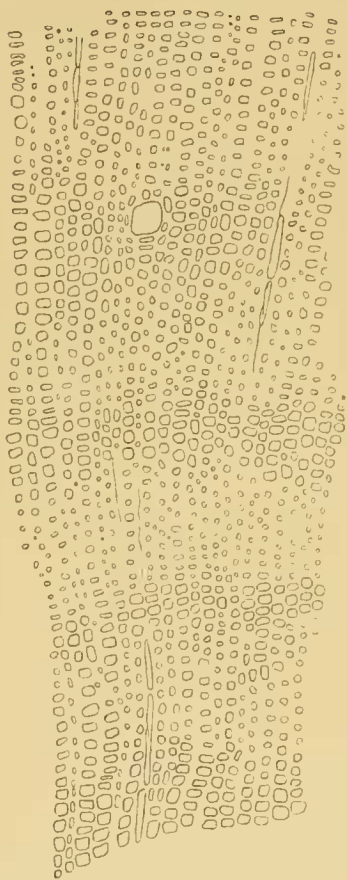


Fig. 2. *Pseudotsuga Douglasii*.
112 G. forst.

¹⁾ Vid. Selsk.'s Overs. 1896 S. 410—11, Fig. 2 og 3.

²⁾ Man sammenligne hermed SORAUER, Handb. d. Pflanzenkrankheiten, 2te Auflage 1896, S. 384. S. fører det Slags Fænomener tilbage til formindsket Barktryk.

³⁾ LUTZ, Beiträge zur Physiologie der Holzgewächse. Fünfstück, Beiträge zur wissensch. Botanik, I. 1895.

⁴⁾ FR. SCHWARZ, Physiologische Untersuchungen über Dickenwachstum und Holzqualität von *Pinus silvestris* 1899, S. 237.

⁵⁾ STRASBURGER, Ueber den Bau und die Verrichtungen der Leitungsbahnen in den Pflanzen, 1891.

2 Gange i 1 Aar, hvilket kunde konstateres i flere af Stammens Aarringe samt i en af Sidegrenene. Strasburger nævner ikke direkte, at det første hostvedagtige Ved gik jævnt over i det andet vaarvedagtige, men at dette har været Tilfældet er det tilladt at slutte deraf, at han udtrykkelig fremhæver, at den følgende Aarrings Vaarved var skarpt afsat mod den abnormt byggede Aarrings afsluttende Hostved.

Aarringen fra 1884 af en i Geel Skov fældet Rødgran viste den i Fig. 3 fremstillede Bygning. Figuren omfatter ikke Aarringen i dennes hele Tykkelse, en Del af det inderste Vaarved mangler, hvorimod den er komplet udadtil. Hen imod de 2 Harpiksge, hvoraf den ene ses helt, den anden delvis, er Dannelsen af Ved med Hostvedkarakter begyndt, men noget uden for Harpiksgeene bliver Trakeiderne igen videre, om just ikke saa tyndvæggede som i Vaarveddet, for derefter længere ude at afsluttes som normalt Hostved. Paa Stammetværnsnittet er dette egentlig ikke meget iøjnefaldende for det uvæbnede Øje, kan tilnød skimtes for Lupen, men i det radiale Længdesnit har denne Aarring ret tydeligt oplost sig i 2, saa tydeligt i alt Fald, at man sikkert, dersom man holdt sig til dette Snit, vilde tælle Aarringen dobbelt. Som Billedet viser, er der ikke Tale om under Mikroskopet at forveksle den med 2 Aarringe.



Fig. 3. *Picea excelsa*.
80 G. forst.

Af mine Optegnelser om disse Forhold skal jeg fremdrage endnu et Eksempel, fordi det godt viser, hvor ringe en Anomali, histologisk set, der skal til, for at frembringe en Ringdannelse. Fig. 4 viser en Del af det indre af en Aarring af en Ædelgran. I dette Billede ses i 2 Bælter en radial Forkortning af Trakeiderne, men meget svagt markeret og gaaende ganske jævnt over i det øvrige Trakeidevæv. For det uvæbnede Øje viste der sig her meget tydeligt en ringformet Stribe, der for Lupen opløste sig i 2 tætstaaende Ringe. Ganske tilsvarende Tilfælde, nemlig at en for det uvæbnede Øje ret skarp Grænse under Mikroskopet oploser sig i et meget udvisket Bælte, har jeg ogsaa andetsteds iagttaget hos Ædelgran; det er forbausende, saa lidt der skal til, for at frembringe en saadan Linje.

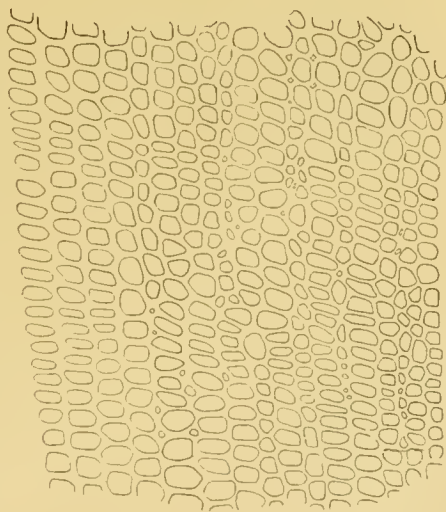


Fig. 4. *Abies pectinata*. 140 G. forst.

ROBERT HARTIG bruger flere Steder¹⁾ Udtrykket Dobbeltringe om saadanne

¹⁾ Forstlich-naturwissenschaftliche Zeitschrift Bd. IV, Doppelringe als Folge von Spätfrost; Lehrbuch der Pflanzenkrankheiten, 1900, S. 220--21.

Aarringe, i hvilke Kambiet har reageret paa en Foraarsfrost, indtruffet efter at Udviklingen af den ny Aarring var begyndt, og denne Betegnelsesmaade har ogsaa andetsteds Hævd. De Bygningsforhold, der ligger til Grund herfor, er dog i Virkeligheden meget langt fra at have nogen Lighed med dem, der linder Sted ved en Aarringsgrænse, om end der for det uvæbnede Øje kan være nogen Lighed med en saadan, dog vistnok sjældent mere end at man temmelig let ser Forskellen. Hartigs Afbildninger (F. nat. Z. 4, S. 5 og 7, Pflanzenkr. S. 220 og 221), henholdsvis af en Fyr og af en Rødgran, er meget nøjagtige og gode, og et Blik paa dem er tilstrækkeligt til at vise deres Forskel fra en Aarringsgrænse.

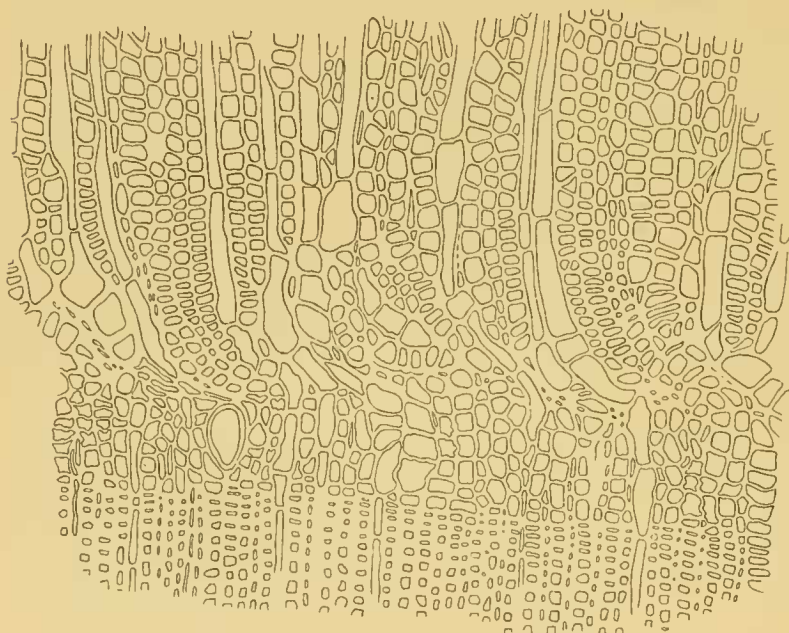


Fig. 5. *Pseudotsuga Douglasii*. 120 G. forst.

I hoeslaaende Fig. 5 findes en ganske tilsvarende Afbildning af en *Douglasgran*, taget i Eftersommeren 1901 paa Boller Distrikt og hvis Top har lidt af Frost i Foraaret 1900. Billedet viser det yderste Hostved af den tredjeyderste og en Del af det først dannede Ved af den næstyderste Aarring, og Frostvirkningen har vist sig efter Dannelsen af kun nogle faa Lag Vaartrakeider.

Denne Ringdannelse var tydelig for det uvæbnede Øje og for Lupen, men da den ligger saa tæt ind paa den forudgaaende Aarringsgrænse, var Faren for Forveksling ikke saa stor; skønt der jo forresten intet var i Vejen for, at der af en eller anden Aarsag kunde have dannet sig en abnorm smal Aarring.

I Foraaret 1899 har en Ædelgran-Bevoksning i Geel Skov lidt meget stærkt af Frost, hvoraf Bevoksningen fremdeles tydeligt bærer Spor. Fig. 6a viser et Tværnsnit af Veddets af den 4 Aar gamle Del af en saadan Stamme. Flygtig set kunde det se ud, som om her var 5 Aarringe, men man vil dog hurtigt iagttage, at den 2den og 3dje indenfra tilsammen udgør 1 Aarring. Frostringen ligger her midt i Aarringen, hvilket bidrager noget til at gøre en Fejltagelse lettere. Det er dog, selv ved en svag Forstørrelse, let at iagttage, at denne falske Aarringsgrænse

ikke er skarpt afsat som den ægte, men derimod er lige som noget flosset og ud-
 efter jevnlig trukket ud i smaa Spidser, hvilket skyldes Marvstraalernes Udvidning

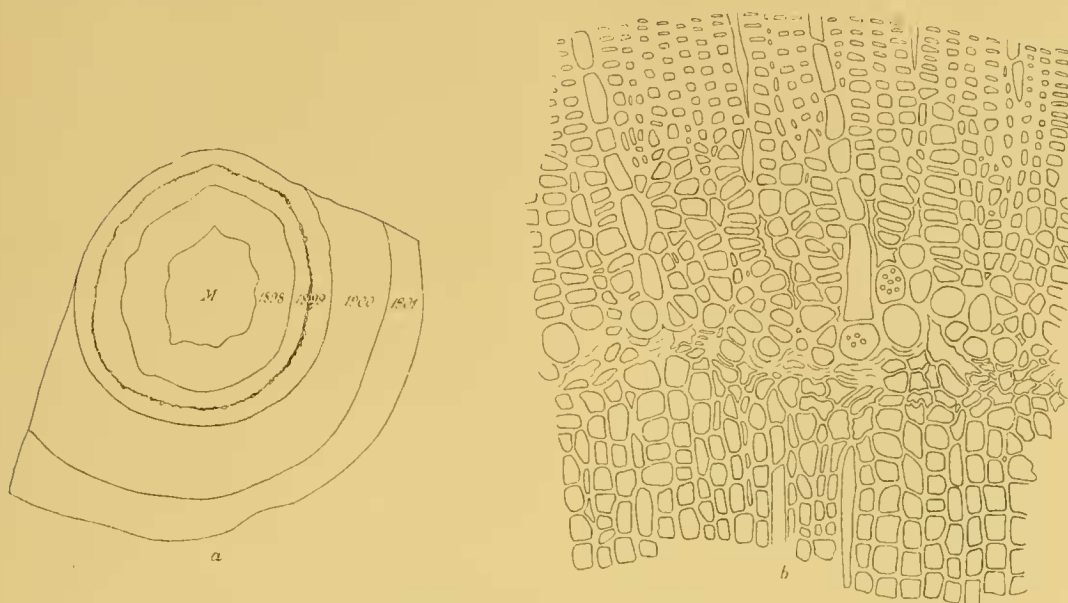


Fig. 6. *Abies pectinata*. a 12 G., b 200 G. forst.

og derefter følgende ret bratte Afsmalning. Den er ogsaa af en brunlig Farvetone. Fig. 6 b, der omfatter et i radial Retning fuldstændigt Tværsnit af Aarringen fra 1899, giver tilstrækkelig Oplysning om Bygningen af denne falske Aarringsgrænse. Det ganske unge Ved er bleven destrueret og komprimeret, det sidste enten af den indlejrede Is eller ved det udenfra kommende Ved, der udvikler sig, efter at Kambiet har genoptaget sin Virksomhed. Aarringen afsluttes med normalt Høstved.

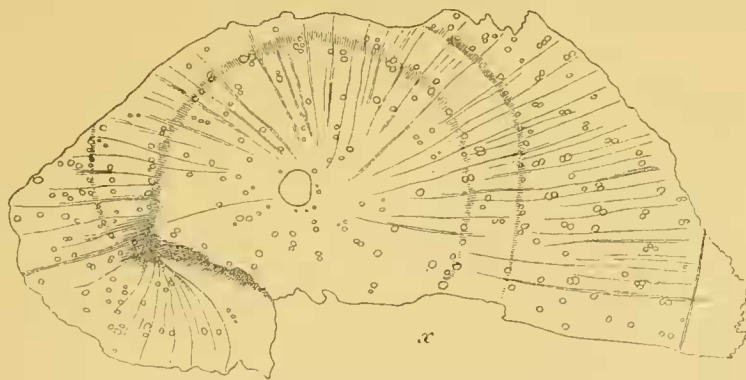


Fig. 7. *Ailanthus glandulosa*. 11 G. forst.

En anden Aarsag til Fremkaldelsen af ringformet Albrydelse i den normale Vedudvikling har vi i Længdesaar paa Planten, frembragt ved ydre Vold. Jeg har

antydte dette i en tidligere Afhandling¹⁾, men skal her gaa lidt nærmere ind derpaa.

Fig. 7 er tegnet efter en Længdebeskadigelse paa den nederste Del af Stammen af en 2aarig *Ailanthus glandulosa* i Nærheden af Overgangen til Roden. Billedet omfatter foruden den lille Marv de 2 Aarringe, af hvilke den inderste er delt i 2 Lag. Til højre i Billedet ses lidt af Barken. Foroven mangler hele den anden og noget af det efter Beskadigelsen dannede af den første Aarring. Beskadigelsen har fundet Sted i det første Aar inden Afslutningen af Vækstperioden, og paa Grænsen af det Ved, der har dannet sig før, og det, der har dannet sig efter at det voldelige Indgreb fandt Sted, findes der en Uregelmæssighed i Veddannelsen, der strækker

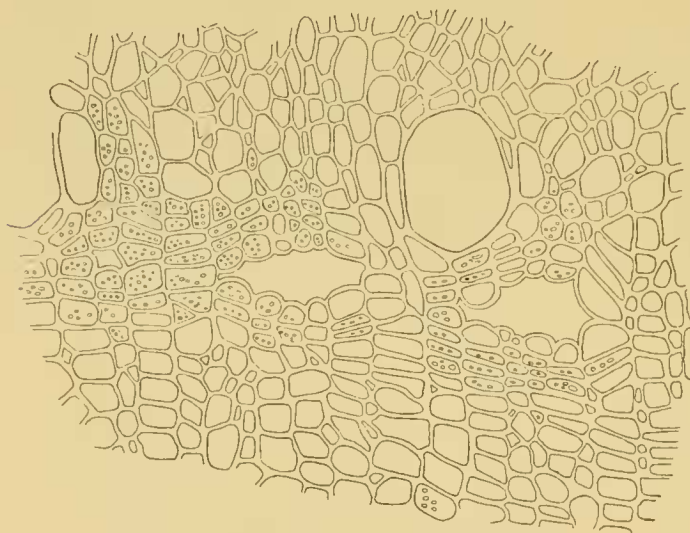


Fig 8. *Ailanthus glandulosa*. 200 G. forst.

1 Fig. 8, der viser et lille Parti af den falske Aarringsgrænse, stærkere forstørret, ses 3 saadanne Lakuner, den længst til venstre meget lille, kun omgivet af 6 Celler.

Fig. 9 viser Snittet gennem en 2-aarig Gren af *Corylus Avellana*, taget i Oktober 1901, med paasiddende Bark. Grenen er bleven beskadiget ved et Længdesaar temmelig langt hen paa den 2den Sommer. Kallusranden er derfor ikke naaet ret langt frem. Beskadigelsen har borttaget et Afsnit af det 2det Aars Vedlag og omtrent strøffet den 1ste Aarring. Paa Randen af 2det Aars Vedlag, har Beskadigelsen grebet noget mere ind i Barken, saaledes som ses paa de to med + mærkede Steder. Ud for Saarranden, til begge Sider, ses en Stribe i Veddets, der markerer den Region, hvortil Veddannelsen var naaet, da Indgrebet fandt Sted. Denne falske Aarringsgrænse griber imidlertid ikke helt rundt fra den ene Rand af Saaret til

¹⁾ Overvoksning efter Længdesaar hos Lærk og nogle andre Træer. Vid Selsk.s Overs. 1903.

sig helt rundt fra den ene Saarrand til den anden. For en meget svag Forstørrelse viser den sig som en mørk Linje, eller rettere et ikke videre skarpt kontureret Bælte, langs hvilket der findes nogle flere Kar end ellers (x i Figuren). Den mørke Tone kommer af, at Vævet her hovedsagelig bestaar af stivelsefyldte Parenkymceller, der ligger ordnede som hen imod en Aarringsgrænse. Men det interessanteste ved dette Bælte er de schizogene Lakuner, der dannes her.

den anden, saaledes som nylig nævnt hos *Ailanthus*, men kan kun følges et Stykke ind fra hver Side, som det ses af Fig. 9. I Billedet Fig. 10 ses, stærkere forstørret, Overgangen fra det Ved, der er dannet før, til det, der er dannet efter Beskadigelsen, og der findes her en Struktur, der paa sine Steder virkelig meget minder om en almindelig Aarringsgrænse. Men ved Undersøgelse af den normale Del af Grenen, der ligger under — længere nede end — Saaret, er det let at se, at vi her har med en falsk Aarringsgrænse at gøre. Iagttagelsér som disse over *Ailanthus* og *Corylus*, sammenholdte med hvad jeg andelsteds har meddelt om *Larix*, kaster Lys over K. WILHELM'S Forsøg med kunstig Frembringelse af falske Aarringe¹⁾ og viser eller sandsynliggør i alt Fald, at det ogsaa der er Indgrebet i Stammens Integritet, snarere end Aflovningen, der har Ansvaret for den omtalte Abnormitet.

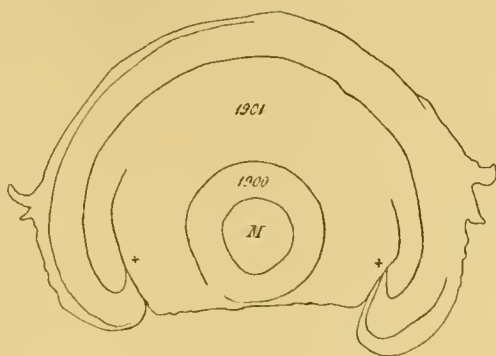


Fig. 9. *Corylus Avellana*.

I mange Tilfælde drejer det sig her om en lokal Udvidelse af Marvstraalecellerne, og uden at behøve at gaa nærmere ind derpaa, skal jeg henvise til de



Fig. 10. *Corylus Avellana*. 187 G. forst. Det skraverede til venstre i Billedet antyder Randen af Saaret.

omslaaende Afbildninger af *Pruus spinosa* og *Salix cinerea*, der begge fremstiller Marvstraalernes Luksurieren ud for Randene af et Længdesaar.

¹⁾ K. WILHELM, Die Verdoppelung des Jahresringes, vorläufige Mittheilung. Bericht der deutsch. bot. Gesellsch. Bd. I, 1893 S. 216 Jvf. Vid. Selsk.s Overs. 1896 S. 423.

Et andet Forhold, der kan give Anledning til en falsk Aarringsgrænse og derved en tilsyneladende Fordobling af en Aarring, er Beskæring eller Klipping af Træer og Buske. I min ovenfor nævnte Afhandling om abnorme Lovforholds Indflydelse paa Aarringsdannelsen har jeg belyst dette ved flere Eksempler, som jeg henviser til, og jeg skal her indskrænke mig til at styrke, hvad jeg tidligere herom har meddelt, ved at anføre et nyt Eksempel til Belysning af denne Anomali. Fig. 12

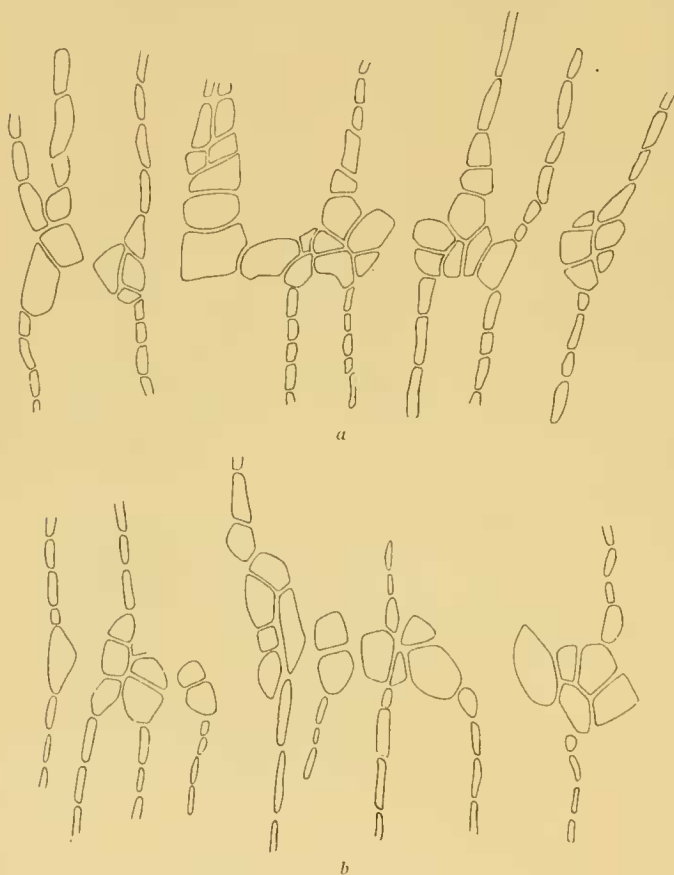


Fig. 11. a *Prunus spinosa*, b *Salix cinerea*. 250 G. forst.

Bygning Sted. Ogsaa Veddets egentlig mekanisk virksomme Elementer mangler, Anordningen er regelmæssig radierende, Cellerne er fladtrykte i radial Retning og forholdsvis tyndvæggede samt fyldte med Stivelse, hvad der ikke er gengivet i Billedet. Med andre Ord, det hele Billede minder mere om den kambiale Anordning af Vævet, om en meget ringe Differentiering, saa meget mere, som Cellerne, hvad jeg andetsteds har gjort opmærksom paa, og hvad Længdesnittet viser, er af en langstrakt Form. Jeg fastholder derfor den tidligere foreslaaede Betegnelse Svækkelsesring for dette Bælte, hvilket jeg tilskriver nogen Betydning for For-

viser et i radial Retning fuldstændigt Tværsnit af Vedringen i en 1-aarig Gren af *Pyrus communis*. Det er let at se, hvor langt Grenen var kommen i sin Udvikling, da Virkningen af Beskæringen gjorde sig gældende; den viste sig i et fuldstændigt Ophor af Karudviklingen, som det ses i et med Periferien nogenlunde parallelt Parti af Veddets; og da Karudviklingen efter det nye Skuds Fremkomst er begyndt igen, tages der fat med snævrere Kar end der egentlig hører Regionen til, hvilket kan ses deraf, at de atter bliver videre inden de igen snævres ind ud imod Aarringsgrænsen. Den specielle Bygning af dette karfri Bælte ses af Fig. 13, der viser, at det ingenlunde blot er Manglen af Kar, der her er ejendommelig, men at der tillige linder en helt igennem afvigende

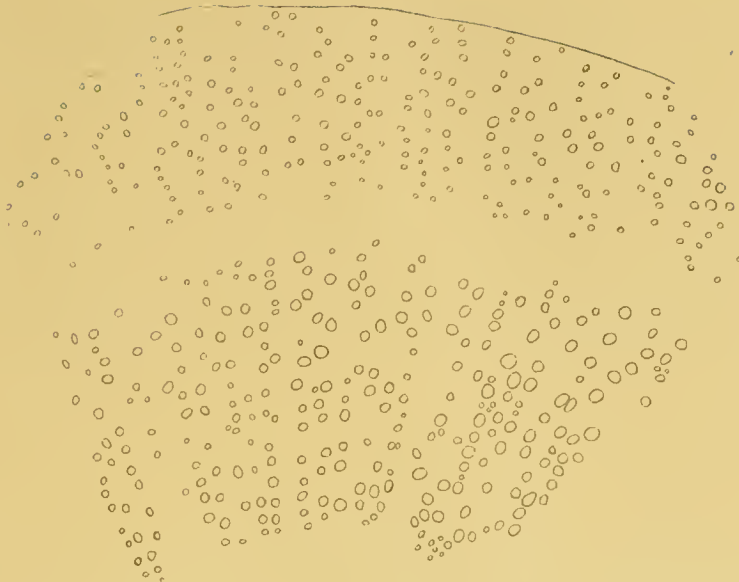


Fig. 12. *Pyrus communis*. 75 G. forst.



Fig. 13. *Pyrus communis*. Stärkere forst.

staaelsen af, hvad der ligger til Grund for Aarringens Udvikling hen imod Vækst-periodens Ophor¹⁾. FRANK SCHWARZ synes at være kommet til en lignende Opfattelse²⁾. Denne Ring kan for Lupen godt fremtræde som en kredsformet Stribe i Aarringen. Fra en virkelig Aarringsgrænse er den paa Grund af sin jevne Overgang udadtil kendelig forskellig.

Jeg har nu i det foregaaende sammenstillet de lagttagelser over Ringdannelse inden i en Aarring, som jeg har havt Lejlighed til at gøre, og jeg maa fremdeles fastholde, at falske Aarringsgrænser, byggede som en ægte Aarringsgrænse, maa være yderst sjældne. Jeg har overhovedet endnu ikke selv truffet paa nogen og kender dem altsaa kun gennem Litteraturen, i hvilken Angivelserne sikkert ogsaa kan reduceres til overmaade faa, naar de underkastes en nøjagtig Prøve.

Undertallige Aarringe.

I min tidligere Behandling af dette Emne³⁾ har jeg foruden Meddelelsen af mine egne lagttagelser givet en Fremstilling af det lidet paalidelige, jeg herom kunde finde i Litteraturen, hvilket hovedsagelig har indskrænket sig til ROBERT HARTIG'S lagttagelser paa ganske unge Træer. Det er overhovedet kun paa saadanne, for saa vidt det drejer sig om Stammen, at man kan opnaa ganske sikre Resultater. De Træer, paa hvilke jeg selv kunde konstatere Udeblivelse af Aarringe, var i den Grad undertrykte eller retarderede, at jeg mente at kunne udtale, at Spørgsmaalet ingen praktisk Betydning havde, da vedkommende Træer sikkert aldrig vilde naa til at blive anstændige Skovtræer. De af Rob. Hartig undersøgte Weymouthsfyr synes at have været noget mindre undertrykte, og Forfatteren giver som praktisk Resultat det Raad «bei Altersermittlungen ziemlich gleichaltriger Bestände die unterdrückten Bäume ganz unberücksichtigt zu lassen»⁴⁾.

For ældre Træers Vedkommende er det vist en meget mislig Sag at træffe en Afgørelse. Der kræves dels fuldstændig Sikkerhed for Alderen af vedkommende Træ eller Del af Træet og dels en ved mikroskopisk Undersøgelse sikkert Garanti for, at der ikke skjuler sig flere Aarringe i en tilsyneladende enkelt. Selv paa ikke saa meget gamle Egestammer fra Kærgaard Egekrat, overgivet mig til Aldersbestemmelse af Hr. S. C. de Röpstorff, har jeg havt meget vanskeligt ved nogenlunde at fastslaa Alderen efter Aftælling af Aarringe⁵⁾, og jo større og ældre Træerne bliver, desto vanskeligere bliver denne Kontrol.

¹⁾ Slg. Det forstlige Forsogsvæsen Bd. 1 S. 58.

²⁾ I. c. S. 276.

³⁾ Aarringsstudier. Tidsskrift for Skovvæsen Bd. XI. 1899 B.

⁴⁾ ROB. HARTIG, Das Aussetzen der Jahresringe bei unterdrückten Stämmen. Zeitschrift für Forst- und Jagdwesen, I. Bd., 1869.

⁵⁾ Slg. S. C. de RÖPSTORFF, Egekrat i Klitten, Tidsskrift for Skovvæsen Bd. XIII, 1901 B.

I den fremmede Litteratur har jeg i de senere Aar kun truffet yderst lidt af selvstændige Bidrag, der har Interesse for os i denne Henseende, saaledes hos FRANK SCHWARZ¹⁾, der har iagttaget dette Forhold hos en Skovfyr. I vor egen Litteratur foreligger der fra den nyeste Tid en Undersøgelse, der bør nævnes i denne Sammenhæng, saa meget mere som det er et af de faa Forsøg, jeg kender, paa for ældre Træers Vedkommende at sammenholde Tallet af Aarringe med Træernes ad historisk Vej dokumenterede Alder. Kgl. Skovrider J. HELMS, der foruden at være praktisk Forstmand har megen botanisk Sans og et fint Blik for vore Skovtræers biologiske Forhold, har i en større Afhandling om Skovfyrren²⁾ paavist, at der for enkelte Provellader var en paafaldende stor Forskel mellem Alderen og Stødets Aarringe, talte med megen Nojagtighed. Med Udeladelse af 2 maaske lidt tvivlsomme Tilfælde³⁾, hvor Differensen gik op indtil 12 Aarringe, fandtes der en Underbalance paa 6 Aarringe. Det forstaar sig, at der er taget Hensyn til, hvad Alder Træet kunde anlages at have, da det var naaet til den Højde, hvor Stødets blottede Flade befandt sig og hvor altsaa Aftællingen havde fundet Sted. Forf. fremsætter formodningsvis den Forklaring⁴⁾, at Jorden omkring Stammen har hævet sig noget ved Roddernes Vækst, saa Stødets Højde er bleven mindre end Afstanden fra dets Overkant til det Sted paa Træet, hvortil Jorden oprindelig naaede, altsaa den egentlige Grænse mellem Rod og Stængel. Han synes dog ikke at lægge megen Vægt, paa denne Forklaring, men jeg har nævnt den, fordi den mulig i visse Tilfælde kunde finde Anvendelse. Helms udtaler sig saaledes om det paagældende Fænomen i Almindelighed⁵⁾: «Hvad undertallige Aarringe angaar, mener jeg at have truffet det ret ofte».

Til mine tidligere Meddelelser skal jeg føje et Par senere tilkomne Iagttagelser over undertallige Aarringe i stærkt undertrykte Stammer af unge Træer.

Af Professor C. V. PRYTZ modtog jeg i Sommeren 1900 nogle meget smaa Ege, saaede i Foraaret 1888 paa Agermark under Ravnholt Skovdistrikt, med den Tilføjelse, at der fandtes en Del saadanne i Striberne, mens Hovedmasserne af Planterne var c. 10 Fod høje eller mere. Af disse smaa Ege var en omtrent 37 cm. høj med et Tværmaal foruden af 4 mm., en anden omtrent 40 cm. høj med et Tværmaal foruden af 5 mm. Paa ingen af disse kunde jeg udrede mere end 8 Aarringe; de skulde have 13. De havde begge grønne Blade i Toppen.

En selvsaaet *Acer Pseudoplatanus* fra Geel Skov, meget undertrykt, viste i en 11-aarig Stammedel kun 8 Aarringe. Et andet meget reduceret Træ af samme Art og fra samme Sted viste i en 7-aarig Stammedel, der her kun var 3 mm. tyk, saa godt som ingen Aarringsadskillelse tydeligt; kun hist og her kunde stribevis paavises Aarringsgrænse.

¹⁾ l. c. S. 212.

²⁾ J. HELMS, Skovfyrren paa Tisvilde—Frederiksværk Distrikt. Tidsskrift for Skovvæsen XIV, B, 1902.

³⁾ D. v. s., hvor der muligvis havde fundet en Efterbedring Sted.

⁴⁾ l. c. S. 223.

⁵⁾ Meddelelse i Brev.

Paa Palsgaard Distrikt (Landbohøjskolens Skovbrugsekskursion i September 1901) iagttoges nogle 23 Aar gamle meget retarderede Rødgraner i Rosenske Plante-huller. En nærmere undersøgt Plante var fra Roden omtrent 40 cm. høj; den viste i sin nedre Del, hvor jeg efter den forholdsvis kraftige Udvikling af de første Aar-ringe at dømme mente at kunne gaa ud fra at den havde sine fleste Aarringe, 6—13 Ringe. Men paa Grund af disses meget uregelmæssige og ufuldstændige Ud-vikling er den udførligere behandlet under «Ufuldstændige Aarringe».

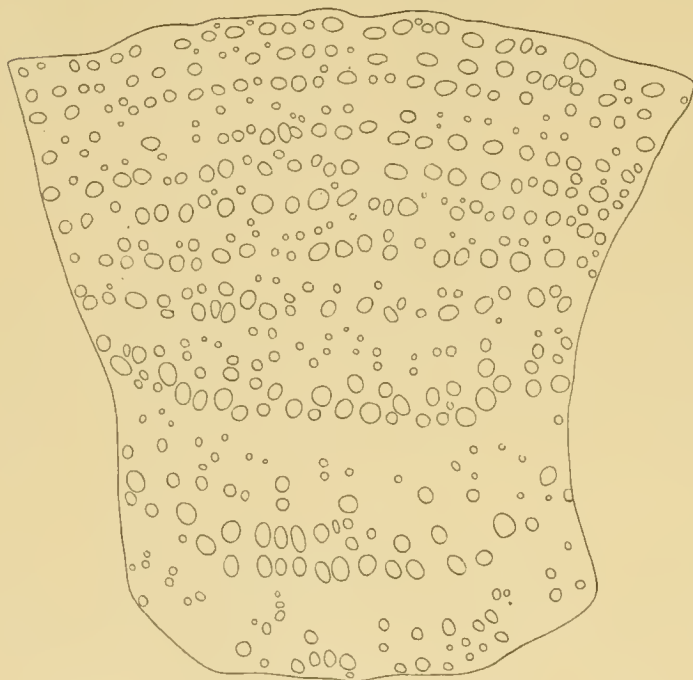


Fig. 14. *Populus alba*. 75 G forst.

Der er imidlertid en anden Region i Træerne, hvor der kunde være Grund til at gaa dette Forhold efter, nemlig ude i Forgrenin-gerne, der, hvor der er en stærk Udvikling af Dværg-grene.

Forst et Par Eksempler paa, hvor stærkt reduceret Organet kunde være uden dog at opgive nogen af sine Aarringe.

En 6 Aar gammel c. 1 mm. tyk Gren af *Fagus silvatica*, der bestod af et Langskud, oven for hvilket der var 5 Dværggrene. Her kunde uden for stor Vanske-lighed paavises Tilstede-værelsen af 6 Aarringe, der dog enkelte Steder var ret utydelige.

En afkastet Gren af en 8 Aar gammel *Populus nigra*, hvis nederste 5 Aarsskud nærmest havde Karakter af Dværggrene, havde med en Vedradius af 1.15 mm. alle sine 8 Aarringe i det nederste Aarsskud.

En afkastet Gren af *Populus alba*, 9 Aar gammel, ligeledes med de nedre Aars-skud udviklede som Dværggrene, havde i det næstnederste Aarsskud med en Vedradius af 1.12 mm. alle sine 8 Aarringe; her bliver altsaa gennemsnitlig kun 0.14 mm. til hver Aarring.

En anden afkastet Gren af *Populus alba*. Det undersøgte Aarsskud 11 Aar gammelt; det udenfor liggende Stykke, bestaaende af 10 Aarsskud, er 21.3 cm. langt, de fleste Skud havde udpræget Karakter af Dværggrene. Skuddet havde de 11 Aar-ringe, der tilkom det, men den hele Vedradius var kun 1.20 mm. tyk, og heraf til-

faldt over det halve de 3 inderste Aarringe; de 8 yderste var tilsammen 0.55 mm., saa at der altsaa gennemsnitlig kun tilfaldt hver af disse Aarringe 0.07 mm. Bygningen af dette Ved er illustreret ved Fig. 14, i hvilken alle 11 Aarringe uden Vanskelighed kan ses. Et Billede som dette anskueliggør ret godt den Rolle, som Dværggrenene spiller, idet de anvender yderst lidt paa sig selv, men lader saa at sige alt det Bygningsstof, de producerer, komme andre Dele af Træet til Gode. Dværggrenenes egen Vedakse kommer derved næsten udelukkende til at staa i Ledningens Tjeneste.

Vi vil derefter se paa nogle Tilfælde, hvor Organernes svage Udvikling ogsaa har ført til en Reduktion i Aarringenes Antal. Materialet er fra Landbohøjskolens Have.

Fagus silvatica, taget i November 1901. I hestaaende Figur er afbildet Tværsnittet gennem en 7 Aar gammel c. 1 mm. tyk Gren fra et Langskud, ovenfor hvilket der var 6 Dværggrene. Her var Bygningen saaledes, at det ikke var mig muligt at udføre mere end 3 Aarringe, hvilket dog maaske kan skyldes Sammensmeltning af Aarringe. Saaledes viser det sig ved svagere Forstørrelse, men heller ikke ved stærk Forstørrelse ses andet. I Fig. 16 har jeg fremstillet et i radial Retning helt Tværsnit, der var saa tyndt, at det nøjagtig kunde følges Celle for Celle. Man vil her inde i Veddet ikke kunne paaavise mer end 2 Aarringsgrænser, og jeg opfatter dette Billede saaledes, at hvad der ligger indenfor *a. a.* er den ældste Aarring, altsaa den, der er dannet 1895, hvad der ligger udenfor *b. b.* indbefatter det Ved, der er dannet 1897—1901. Selvfølgelig var Grenen frisk og bladbærende.

Fagus silvatica. En 2.5 mm. tyk Gren, 11 Aar gammel. Bestod væsentlig kun af lutter Dværggrene; kun i det sidste Aar havde der dannet sig to forlængede Skud, et paa det relative Hovedskud, et paa en af de faa Sidegrene. Vedradius 0.74 mm. Af de 11 Aarringe, der skulde være, var det kun muligt at paaavise 10, og mange Steder lod de fleste Aarringe sig overhovedet ikke adskille. Svarende til de to i det sidste Aar dannede længere Skud var dette Aars Vedring

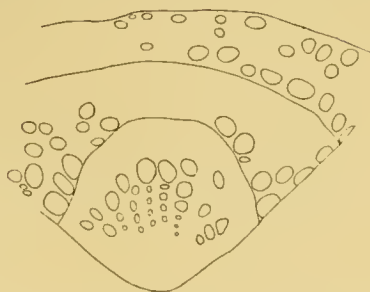


Fig. 15. *Fagus silvatica*. 120 G. forst.



Fig. 16. *Fagus silvatica*. 300 G. forst.

ogsaa forholdsvis bred. Ogsaa den først dannede Aarring var nogenlunde bred. De mellemliggende 8 var gennemsnitlig kun 0.06 mm. brede.

Fraxinus americana. Et 8 Aar gammelt af lutter Dværggrene bestaaende Skud. I det ældste af dets Aarsskud med en Vedradius af 1 mm. kunde der ikke paa-vises mer end 6 Aarringe, og sine Steder var Adskillelsen i Aarringe overhovedet umulig ved den mikroskopiske Undersøgelse; for Lupen endsige for det uvæbnede Øje var absolut ingen Grænser at se. Skuddet havde veludviklede friske Blade i Spidsen. Væsentlig det samme var Tilfældet med et andet, ligeledes 8 Aar gammelt, af lutter Dværggrene bestaaende Skud af samme Træ.

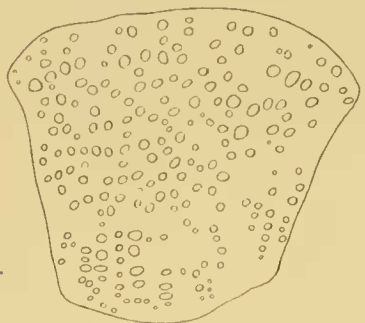


Fig. 17. *Pyrus acerba* 80 G. forst. I det ældste Aarsskud fandtes, med en Vedradius af ubetydeligt over $\frac{1}{2}$ mm., ingen kendelig Adskillelse i Aarringe, hverken naar der toges Hensyn til Karrenes Fordeling eller til den øvrige Vedstruktur (Fig. 17).

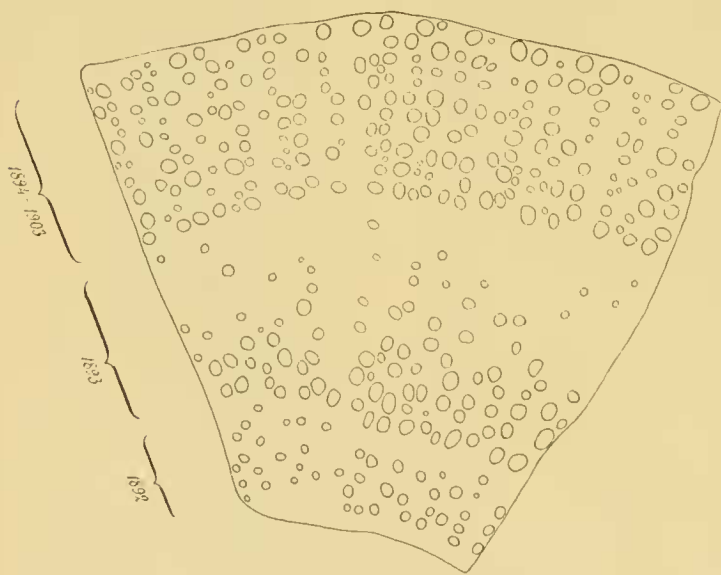


Fig. 18. *Sorbus Aria*. 75 G. forst.

Sorbus Aria. Et 11 Aar gammelt Skud, de 10 sidste Aarsskud udprægede Dværggrene. I det 11 Aar gamle, forlængede Aars-skud er Vedradius henved 0.9 mm. Tydeligt skelnes de 2 inderste Aarringe, tilsammen 0.55 mm. tykke med ret veludviklet Styrkevæv foruden Karrene. De sidste 9 Aars Vedproduktion andrager tilsammen kun 0.35 mm., og her lader det sig ikke gøre at skelne Aarringe. Der er i disse 9 Aar hovedsagelig kun dannet Kar.

Næsten ganske det samme Indtryk faar vi af en anden Gren af samme Træ, 12 Aar gammel. De 11 sidste Aarsskud er udprægede Dværggrene. Da det er et ejendommeligt Billede, dette Tværnit giver, har jeg afbildet det hosstaaende. Den hele Vedradius er 0.92 mm. Den næstældste Aarring er meget markeret og indtager omtrent det halve af Vedradian; paafaldende er de særdeles faa Kar i denne Aarrings yderste

Halvdel; der er her dannet et Væv, der stiver den tynde Gren godt af. De sidste 10 Aars Vedmasse har tilsammen en Radius af ikke meget over 0.3 mm. og bestaar ganske overvejende af Kar; det er næsten rent Ledningsvæv. Denne Bygning kan vel opfattes som et Udtryk for en Reaktion paa de ringe mekaniske Krav, der stilles til en Akse som denne, hvor der Aar efter Aar kun dannes saa yderst smaa Skud, hvis vel fungerende Blade dog kræver rigelig Tillførsel af Vand.

Der er ingen Grund til at forøge disse Eksemplers Antal, da det anførte er tilstrækkeligt til at vise, at Dannelsen af en Række Dværggrene, hvormed følger en stærkt hæmmet Vedudvikling, kan føre til, at Aarringene bliver undertallige, men at paa den anden Side Vedaksen ogsaa godt kan være særdeles tynd og dog opvise alle de Aarringe, som den efter sin Alder skal have.

Og hvad Stammerne angaar, forbliver Standpunktet det, at i særdeles undertrykte eller paa anden Maade retarderede unge Planter kan Aarringene være undertallige, mens det i større og ældre Træer er forbundet med meget stor Vanskelighed at afgøre dette Spørgsmaal sikkert.

Ufuldstændige, utydelige og sammensmeltede Aarringe.

Ved ufuldstændige Aarringe forstaar jeg saadanne, hvor man vel kan skelne Aarringsgrænsen baade udadtil og indadtil, men hvor Aarringen ikke naar helt rundt, men smalner af til begge Sider, for derpaa fuldstændigt at tabe sig. Skemaet er det, der er fremstillet i hosstaaende lille Figur, og det ses, at vi ved at tælle til den ene Side faar 2 Aarringe, ved at tælle til den modsatte faar 3. Dette er et vel kendt Forhold, som der for saa vidt ikke er nogen Grund til at opholde sig ved; men da jeg aldrig har set det afbildet uden i sine grovere Træk, har jeg dog ment, at det kunde have nogen Interesse at gaa det efter histologisk og paa denne Maade se, hvorledes Aarringen echapperer.



Fig. 19.

En 23 Aar gammel yderst reduceret men endnu med grønne Kviste forsynet Rødgran fra Palsgaard Distrikt er i Henseende til Dimensioner og ydre Forhold omtalt i Afsnittet: «Undertallige Aarringe» (Side 18). Et fuldstændigt Tværsnit af Stammen c. 8 cm. over Jorden er afbildet Fig. 20, og der er her angivet, hvad jeg kunde se af Aarringe ved en Forstørrelse af 25 Gange (det vedføjede Billede er bagefter reduceret); for det uæbenede Øje var det overhovedet vanskeligt at iagttage nogensomhelst Aarringe. 6 Aarringe kan ses fuldstændigt; af disse er den i det 3dje Aar dannede den tykkeste, den 5te og navnlig den 6te meget tynde. Udenfor den 6te Aarring er Forholdene meget uregelmæssige, hvad der tildels staar i Forbindelse med Udvikling af Rødved til den ene Side, og det, der omtales i det følgende, er kun de mer eller mindre ufuldstændige Aarringe, der findes udenfor Nr. 6. Foroven (i den nævnte

Skema for Dannelsen af en ufuldstændig Aarring.

Figur) ses en Aarring kile sig ud i en Spids umiddelbart udenfor den 6te Aarring. Dette har jeg fremstillet noget stærkere forstørret i Fig. 21. Jeg har nu i Fig. 22, der omtrent svarer til det med et Kryds betegnede Parti af Fig. 21, forsøgt at vise, hvorledes en saadan Aarring forsvinder. Betragter vi først den Del af Fig. 22, der

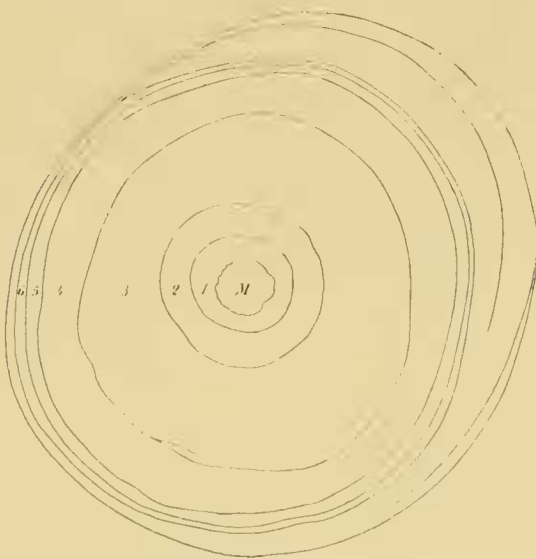


Fig. 20. *Picea excelsa*. 17 G. forst.

er længst til højre, ses den Aarring, der her er Tale om, paa det nævnte Sted at bestaa af 6 Trakeïder, af hvilke de tre inderste maa betegnes som Vaarved, de tre yderste som Høstved. Vi ser nu, hvorledes Aarringen smalner af, indtil den f. Eks. i den 7de—5te yderste Trakeïderække til venstre kun bestaar af 2 Trakeïder, i den 4de yderste af 3, men

atter i den 3dje yderste kun af 2 Trakeïder, i den næstyderste ligeledes, men her er Forholdet noget mindre udpræget; yderst til venstre endelig er den sunket ned til 1 Trakeïde, idet den udenfor liggende er den næste Aarrings første Vaartrakeïde. Selvfølgelig kan man godt forestille sig, at en Aarring eller rettere sagt et Aars Vedlag kun bestod af 1 Lag Celler, men man kan

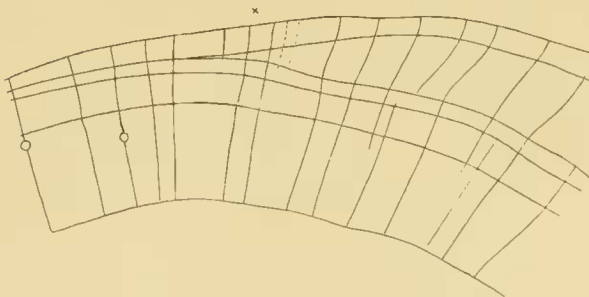


Fig. 21. *Picea excelsa*. 27 G. forst.

ikke paavise det. Derimod kan det paavises, at en Aarring sine Steder er reduceret til 1 Celle i radial Retning, som ovenfor er vist. Ilerover foreligger der saa vidt jeg ved ikke lagtagelser, mens derimod af 2 Cellelag bestaaende Aarringe er paavist af ROB. HARTIG¹⁾. Rodens indre Bygning vil sikkert, især ved meget ekscentrisk Beliggenhed af Marven, frembyde Eksempler herpaa. Saadanne Forhold er f. Eks. omtalt af HUGO v. MOHL for Askens og med endnu større Sikkerhed for Birkens Vedkommende (Bot. Zeitung 1862 S. 273).

Heller ikke utydelige Aarringe eller bedre utydelig Aarringsgrænse er der Grund til at opholde sig længe ved. Jeg skal ved en enkelt lille Afbildning vise, hvor utydelig en saadan Grænse kan være og dog eksistere. Hosstaaende Fig. 23 er fra den nedre Del af Stammen af en særdeles retarderet Ask. Billedet

¹⁾ Slg. ogsaa Fig. 24.

indeholder det yderste af en og Begyndelsen af en følgende Aarring. Den punkterede Linje til hver Side angiver Grænsen, der ved Siderne er ret tydelig, men i det indre er meget svag; dog kan den følges gennem hele Billedet, men det maa indrømmes, at den let kunde overses, og for svag Forstørrelse end sige for Lupen er den ukendelig. Ved en rask Vurdering af Aarringsgrænsen vilde den være gaaet upaaagtet hen.

Her er jo kun Tale om Aarringsgrænser, der ogsaa for den mikroskopiske Undersøgelse er utydelige. For Lupen eller det uvæbnede Øje er utydelig Aarringsgrænse som bekendt almindelig, ogsaa i Tilfælde, hvor Grænsen under stærk Forstørrelse let lader sig paaavise. Jeg kan ikke undlade at medgive omstaaende Afbildning, Fig. 24, der tydeligt illustrerer disse Forhold. Billedet viser 8 Aarringe af en Gren af Rødgran, taget af et meget undertrykt Træ ved Gausdal i Norge og vokset saaledes, at den i fuldstændig vandret Stilling var presset op ad en tyk Granstamme. For det uvæbnede Øje var Adskillelsen i Aarringe paa det her afbildede Sted umulig, under Mikroskopet træder alle 8 Aarringe ihestemt og tydeligt frem; en af dem, den 4de yderste i Billedet, er dog sine Steder reduceret til 2 Trakeider.



Fig. 22. *Picea excelsa*. 280 G. først.

Vi er med det ovenfor omtalte Tilfælde hos Ask naaet meget nær ind paa det, som jeg kalder Sammensmeltning af Aarringe eller intermitterende Aarringsgrænse. Herved forstaar jeg, at Aarringsgrænsen paa en

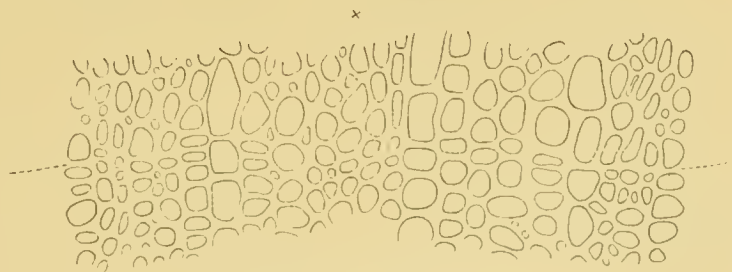


Fig. 23. *Fraxinus excelsior*. 280 G. først.

Strækning helt hører op. Skemaet herfor ses i Fig. 25. Her iagttages lige som i det ovenfor fremstillede Skema 2 Aarringe til den ene Side, 3 til den modsatte Side, men der er den Forskel, at her repræsenterer de 2 Ringe ud for 3 Aarringe, i det foregaaende Tilfælde svarer de faktisk kun til 2 Aars Vedlag.

Ogsaa her skal jeg vise histologisk, hvorledes Aarringsgrænsen holder op, og i den Henseende først henvise til Fig. 26. Dannelsen af Dværggrene hos Bøg kan, som vi ovenfor har set, have en forskellig Indflydelse paa Bygningen af Kvistenes Ved. I nogle Tilfælde kan der dannes undertallige Aarringe, i andre Tilfælde med omtrent samme Tilvækst kan Aarringene være tydelige trods den ubetydelige Tykkelse. Men vi kan ogsaa træffe Tilfælde af nogenlunde tydelige men stedvis sammen-

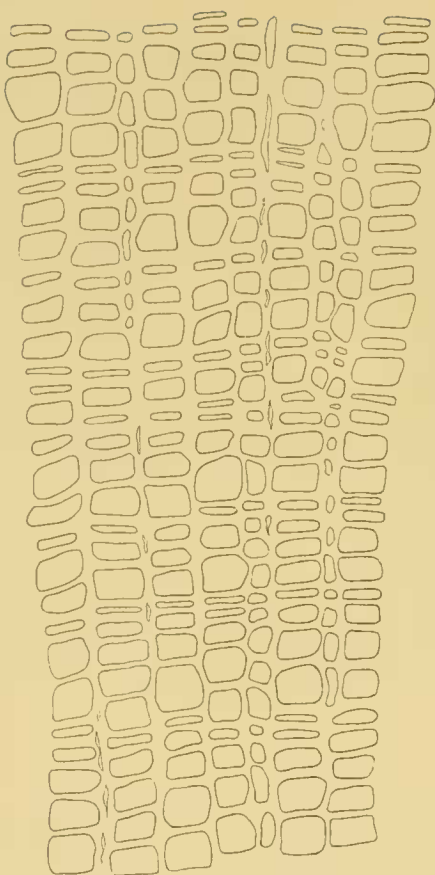


Fig. 24. *Picea excelsa*. 280 G. forst.

11 Aar gamle Del, der her kun viste 8 Aarringe. Karrene var saa faa og smaa og Veddets Elementer saa regelmæssigt radialet stillede, at det hele mere gjorde Ind-



Fig. 25.

Skema af en intermitterende Aarringsgrænse.

tryk af Naaletræved end af Løvtræved. Stammen var paa det undersøgte Sted 2 mm. tyk og Afstanden til Endeknoppens Basis $10\frac{1}{2}$ cm. Det hele Træ var omtrent 17 cm. højt, men de ældste Aargange lod sig ikke bestemme med Sikkerhed. Aarsskuddet bar 5 friske, men smaa Blade. Fig. 27 viser de to næsttinderste Aarringe, altsaa dem, der er dannede 1892 og 1893. Længst til højre er Aarringsgrænsen ret tydelig og længst til venstre nogenlunde tydelig, men her imellem er der flere Partier, hvor den egentlig er udvisket. Hvis vi f. Eks. af disse to Aarringe kun havde Lejlighed til at iagttage de Partier, der er betegnede ved et Kryds, vilde man næppe falde paa, at der forelaa 2 Aarringe.

En anden Ahorn er afbildet Fig. 28. Billedet er fra den 7 Aar gamle Del af

smeltede Aarringe. Kvisten, hvorefter Fig. 26 er udført, var 5 Aar gammel, men kun 1 mm. tyk og sluttede med 4 Dværggrene. Den er taget og undersøgt i Efteraaret 1901. I nogle Regioner viste Tværsnittet tydeligt de 5 Aarringe, der tilkom det, andre Steder lige saa tydeligt kun 4. Efter nogen Søgen lykkedes det mig at finde et Sted, hvor saadanne to Regioner stoder sammen. Fæster vi udelukkende vor Opmærksomhed paa venstre Side af vedføjede Billede, vil det være let at se de 5 Ringe, der foruden ved Karrene og de fladtrykte Høstelementer ogsaa er markerede ved Marvstraalecellerne. Paa den modsatte Side af Billedet vil man lige saa tydeligt kun kunne se 4 Aarringe. Figuren er til begge Sider begrænset af en Marvstraale, men en saadan trækker sig ogsaa omtrent midt igennem (a), og denne danner nogenlunde Grænse, saaledes at hvad der ligger til højre for den har 4, hvad der ligger til venstre for den 5 Aarringe. Det er Aarringene for 1899 og 1900, der her er sammensmeltede. Billedets Begrænsning opadtil falder sammen med Vedgrænsen.

Fig. 27 er tegnet efter en lille undertrykt Ahorn fra Geel Skov, taget i Oktober 1901. Det undersøgte Sted befandt sig i Stammens

en undertrykt Plante. Den svage Aarringsgrænse, der findes i Figuren til højre og til venstre, er, hvad der fremgaar ved Betragtningen af andre Dele af Præparatet, en virkelig Grænse mellem to Aarringe. I omtrent det halve af Billedet er den ukendelig og afgiver derfor et Eksempel paa intermitterende Aarringsgrænse.

Et Eksempel paa dette Forhold, hentet fra en Birk, er afbildet i Fig. 29. Her i den venstre Side af Billedet hører den ellers skarpe Aarringsgrænse pludseligt op, idet en af de større Marvstraaler danner Skellet¹⁾.

Vi ser altsaa her Eksempler paa, at en Aarringsgrænse pludselig kan høre op, saa at to paa hinanden følgende Aars Vedlag stedvis kan være udviklede i fuldstændig Kontinuitet. Og er nu Forholdet saaledes, er der ikke noget i Vejen for at tænke sig den partielle Aarringsgrænse mer og mer reduceret, indtil der tilsidst foreligger to helt sammen-smeltede Aarringe. Dette giver naturligvis en Vanskelighed ved Vurderingen af, om det, at der er for faa Aarringe — her er kun Tale om Organer, hvis Alder kan kontrolleres —, beror paa, at en Grænse

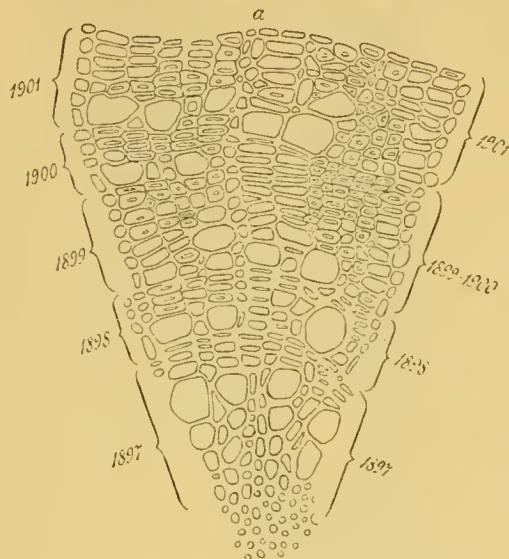


Fig. 26. *Fagus silvatica*. 300 G. forst.



Fig. 27. *Acer Pseudoplatanus*. 280 G. forst.

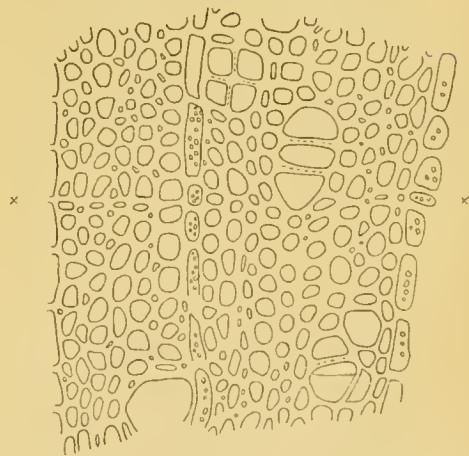


Fig. 28. *Acer Pseudoplatanus*. 280 G. forst.

er udvisket eller rettere ikke dannet, eller om det beror paa, at der et Aar intel Vedlag er dannet. Dette kan, saa vidt jeg skønner, ikke afgøres, og der er derfor

¹⁾ I Tidsskrift for Skovvæsen Bd. XI, 1899, S. 206 har jeg anført nogle Eksempler fra *Pinus Strobus*.

en Mulighed for, at de ovenfor omtalte Tilfælde af undertallige Aarringe i Dværggrenene kunde fores tilbage til Sammensmeltning.

Ufuldstændige Aarringe findes afbildede (men ikke histologisk) i RATZEBURGS Waldverderbnis Tab. 13 Fig. 5 og 8 samt Tab. 17 Fig. 6 (*Pinus silvestris*), intermitte-

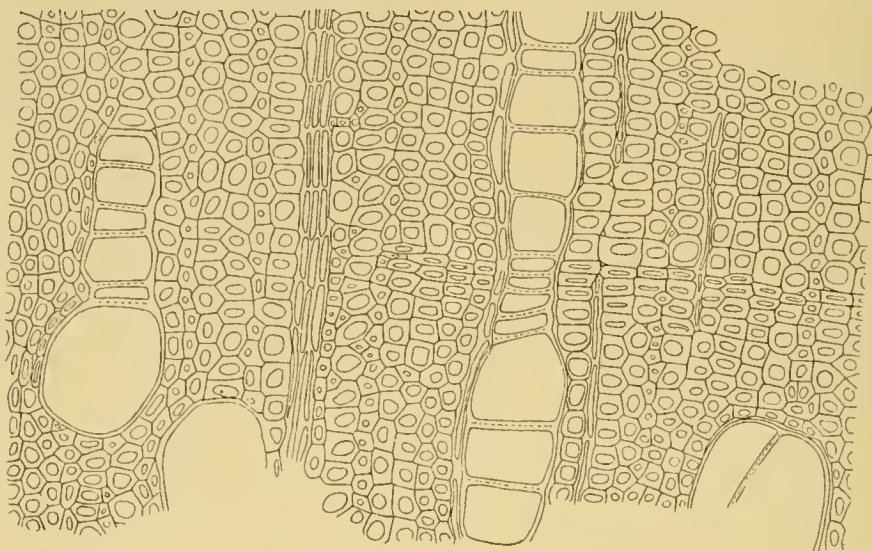


Fig. 29. *Betula verrucosa*. 187 G. forst.

rende Aarringsgrænse sammesteds Tab. 39 Fig. 2 a (*Larix europæa*). Utydelig eller endog udvisket Aarringsgrænse er omtalt af WIELER som forekommende hos *Quercus* i dennes første Aar¹⁾. Som bestemte Eksempler paa udvisket Aarringsgrænse omtaler Wieler unge Potteplanter af *Ribes rubrum*, *Ampelopsis quinquefolia* og *Populus canadensis* samt en Plante i Vandkultur af *Pinus Pinea* (l. c. S. 120—21).

Aarringsbredde og Vedkvalitet, Naboringe.

Den i sin Tid postulerede Sætning, at bredringet Naaletræved har mindre, smalringet mere vægtfyldigt Ved, og at det omvendte skulde være Tilfældet med Lovtræerne, er opgivet i sin Almindelighed. Og dog har Sætningen en vis Gyldighed, naar vi fradrager bestemte Tilfælde. For det første maa vi ikke sammenligne Veddet af forskellige Stammer, men kun forskelligt Ved indenfor samme Træs Stamme. Dernæst maa vi ikke, selv om vi holder os til samme Aarring, undersøgt i samme Højde over Jorden, altsaa taget af samme Skive, sammenligne Veddet

¹⁾ Ueber Beziehungen zwischen sekundärem Dickenwachsthum und Ernährungsverhältnissen der Bäume (Tharander Forstliches Jahrbuch Bd. 12. 1892 S. 84—85. Slg. ogsaa hermed den nævnte Afh. S. 120).

fra den ene Side af Stammen med det fra den modsatte Side. Endvidere gaar det ikke at sammenligne Veddet i samme Højde og samme Side af Træet, men i en betydelig forskellig Afstand fra Marven, hvor altsaa den Alder, Træet har været i, da Veddet dannedes, kommer i Betragtning. Og endelig maa vi ikke sammenligne en og samme Aarrings Ved foroven og forneden i Stammen. Disse speciellere Forhold vil blive berørte senere, og det er ikke saaledes at forstaa, at den ovennævnte Modsætning ikke kan optræde her; det kan den meget godt, men her griber andre Omstændigheder ind, der ogsaa kan føre til lige det modsatte Forhold.

Efter at have elimineret disse 4 Tilfælde, har vi atter Opgaven staaende for os, saaledes at den nu egentlig først bliver reduceret til Spørgsmaalet: Brede eller smalle Ringe. Jeg skønner ikke, at man da kan komme dette til Livs paa anden Maade end ved umiddelbar Sammenligning af Naboringe, idet man opsøger Steder i Veddet, hvor en forholdsvis bred og en forholdsvis smal Aarring støder op til hinanden. Men da der her ikke kan gøres Vægtfyldebestemmelser, maa vi benytte en anden Maade, nemlig, saaledes som Rob. Hartig har gjort, undersøge Forholdet mellem Lysningerne (Lumina) og Væggene, hvilket for Løvtræernes Vedkommende hovedsagelig vil sige det samme som Karlætheden, idet Opmærksomheden naturligvis ogsaa maa være henvendt paa Karrenes Vidde. Dertil kan i visse Tilfælde ogsaa komme Forskelligheder i Styrkevævets Bygning. Nærmere kan vi næppe komme Sagen end ved at sammenligne brede og smalle Aarringe 1) i samme Stamme, 2) i samme Højde af denne, 3) i samme Side af Stammen og 4) i tilnærmelsesvis samme radiale Afstand fra Marven. Den langsommere eller hurtigere Vækst, der fører til Dannelsen af henholdsvis smallere eller bredere Aarringe, maa jo have sin Aarsag, men i Forhold som disse kan det vel i Almindelighed vanskelig siges, hvilken Aarsagen har været i de enkelte Tilfælde.

Vil vi nu med det ovennævnte Forbehold for Øje betragte Forholdet mellem brede og smalle Aarringe hos Løvtræer, saa har det været gjort gældende, at den omtalte Sætning egentlig kun var baseret paa lagttagelsen af det »ringporede» Ved, d. v. s. det, hvor der i Aarringens inderste, først dannede Del optræder store Kar, der udadtil afløses af meget mindre, og af Ved med denne Bygning var det da navnlig Egen, som man havde gjort sine lagttagelser paa. Jeg tror ikke, der er nogen Grund til at opholde sig ved disse Vedsorter; jeg har ikke taget nogen af dem i Haanden og eftersat dem i denne Henseende, uden at det paa det tydeligste har vist sig, at de smalle Aarringe har stærkt porøst Ved i Sammenligning med de brede. Dette gælder f. Eks. ogsaa om *Hippophaë rhamnoides*, hvilken jeg henregner til denne Type. Om den siger NÖRDLINGER¹⁾, at Hohenheimer-Busketternes hurtigt-voksende, tykringede Planter har et let og porøst Ved, de derimod, der forekommer i Dünerne ved Boulogne forholder med meget smalle Aarringe et fintporet, tungt Ved. Men her er det altsaa forskellige Planter, der tilmed har vokset under helt forskellige Vilkaar, der sammenlignes. Jeg har forholdsvis store Stammer baade fra

¹⁾ Die technischen Eigenschaften der Hölzer, 1860, S. 123.

Møens Klint og fra Fosdalen i Vester Hanherred, og her ses tydeligt, at det smalingede Ved er det porøse, sammenlignet med det bredringede indenfor samme Stamme.

Anderledes og vanskeligere stiller det sig med de Traeer, der har spredtporet Ved, d. v. s. Ved, hvor den store Modsætning mellem Karrenes Størrelse og Tæthed i Aarringens indre og ydre Del ikke findes. Dette udelukker ikke, at Karrene kan være enten enkeltvis spredte eller spredte i Grupper. Men ogsaa i en anden Henseende er der en indbyrdes Forskel paa Traerne indenfor denne Gruppe, idet nogle af dem har Karrene næsten absolut ens over hele Aarringen i Henseende til Vidde og Tæthed, andre derimod nærmer sig lidt mer til de ringporede; dette er f. Eks. ofte Tilfældet med Bøg.

En foreløbig Undersøgelse i denne Retning paa Bøg anstillede jeg paa følgende Maade: Aftællingen er sket under 60 Ganges Forstørrelse ved Tegneprismets Hjælp paa Tegnebrættet indenfor en Ramme, der giver en $\square$ Millimeter 60 Gange lineært forstørret. Denne Methode er forholdsvis nem og hurtig. Billedet af Præparatet orienterer jeg saaledes, at Grænsen mellem 2 Aarringe halverer Kvadratet paa Tegnebrættet, saa at jeg altsaa faar 2 sammenstødende — henholdsvis brede eller smalle — Aarrings Høst- og Vaarved; dette kan altid lade sig gøre for de bredes og tilige for de ikke altfor smalle Aarrings Vedkommende. Naar Aarringene er meget smalle, under $\frac{1}{2}$ Millimeter brede, orienterer jeg Billedet, hvis Kar skal aftæles, saaledes, at en saadan meget smal Aarring passerer midt over Millimeter-Kvadratet, hvorefter altsaa følger, at jeg af Naboringene faar henholdsvis det yderste Høstved og det inderste Vaarved med. I Reglen indstiller jeg saaledes, at jeg kan begynde Aftællingen fra Randen af en af de større Marvstraaler. Som man ser forudsætter det foranstaaende, at jeg har 2 brede og 2 eller 3 smalle Aarringe ved Siden af hverandre. I denne rent foreløbige Undersøgelse har jeg ikke maalt Aarringens Tykkelse, men kun ganske i Almindelighed valgt smalle og brede Aarringe, beliggende i hinandens Nærhed. Resultatet af Undersøgelsen af 10 Aarringe af hver Slags findes i den lille vedføjede Tabel. Gennemsnittlig fandtes der 161 Kar pr. Kvadratmillimeter

Antal Kar { Smalle Aarringe pr. $\square$ mm \ Brede Aarringe	201	171	151	154	143	132	147	194	142	182	161
	123	137	109	109	125	123	114	129	127	151	124

i de smalle og 124 i de brede Aarringe, hvorefter følger, at de brede Aarringe var de tættest byggede, fordi der var størst Afstand mellem Karrene.

Metoden tiltalte mig imidlertid ikke, men vil dog være at anvende ved meget brede Aarringe i Ved med en meget ensartet Bygning, hvor man da kan vælge Midten af Aarringen til Aftællingen. I Stedet for valgte jeg ved de følgende Undersøgelser en anden Fremgangsmaade. Jeg udsøgte Steder i Veddets, hvor en smal Aarring fulgte umiddelbart efter en bred eller omvendt, maalte Aarringens Tykkelse, talte Karrene gennem Aarringens hele Bredde, i den ene nøjagtig ud for samme

Region, hvor jeg havde talt dem i den anden, i Reglen mellem de samme Marvstraaer, beregnede Arealet, tilnærmelsesvis en Rektangel, i hvilket jeg havde talt Karrene, og reducerede derefter disses Antal til at svare til et Kvadratmillimeter. Derved opnaaede jeg blandt andet, at Aftællingen i Reglen fandt Sted over et betydeligt større Areal end et Kvadratmillimeter samt at Aarringens Karakter i hele dens Bredde afspejlede sig i Resultatet.

Tavle 1. *Fagus silvatica.*

I.					II.					III.				
Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.
1.58	127	1.15	133	105	3.47	125	2.03	138	110	2.57	124	1.57	145	117
1.25	125	0.83	161	129	3.93	111	2.63	138	124	2.83	120	1.95	128	107
2.00	97	1.07	107	110	3.25	109	2.33	126	116	2.58	162	1.22	217	134
1.78	118	1.23	108	92	3.05	112	2.28	110	98	2.72	136	1.67	153	113
3.62	119	2.87	140	117	5.05	100	3.33	118	118	3.58	114	2.20	170	149
2.37	141	1.82	150	106	2.90	101	2.20	110	109	2.92	153	2.13	175	111
1.20	83	3.03	103	124	1.92	101	1.37	112	111	3.53	127	1.92	163	128
1.67	111	1.03	146	128	2.47	123	1.87	121	98	1.67	158	0.97	183	116
1.27	125	0.90	131	105	2.20	127	1.40	149	117	1.73	136	1.00	153	112
1.37	120	1.00	142	118	2.73	142	2.03	138	97	3.40	110	2.23	117	106
3.75	107	2.47	115	107	2.78	107	1.77	135	126	2.07	127	1.17	132	104
1.12	142	0.78	149	105	2.93	119	1.97	158	133	1.53	153	0.78	180	118
2.67	95	2.03	97	102	2.70	116	1.70	146	126	2.40	131	1.70	151	115
1.93	101	1.23	112	111	2.28	85	1.27	112	132	1.85	144	1.33	149	103
1.67	135	1.08	151	112	1.12	99	0.90	102	103	2.27	117	0.88	178	152
2.78	104	1.78	121	119	1.30	119	0.63	143	120	1.80	135	1.07	140	101
1.42	110	0.78	128	116	1.80	79	0.93	100	127	1.93	137	1.15	154	112
2.78	106	1.52	137	129	2.97	89	2.22	100	112	2.30	109	1.63	110	101
2.55	102	1.25	106	104	2.77	89	1.87	107	120	2.70	96	1.20	119	124
3.17	94	1.97	113	120	2.13	103	1.22	121	117	2.67	99	1.13	135	136

Paa Tavle 1 har jeg givet Resultatet af Undersøgelsen af 3 Bøgestammer¹⁾, betegnede ved I, II og III, 20 lagtagelser i hver over en smal og en bred sammenstødende Aarring. Af de 5 Tal i hver horizontal Række betegner det første og det tredje Bredden i Millimeter af en forholdsvis bred og en forholdsvis smal Aarring, det sidste Antallet af Kar i den smalle Aarring, naar Tallet af dem i den brede

¹⁾ Ved Professor OPPERMANNS Velvilje er der til disse anatomiske Undersøgelser overladt mig et rigt Materiale af analyserede Træstammer saa vel af Løvtræ som af Naaletræ, der af Statens forstlige Forsøgsvæsen har været benyttede til Tilvækstundersøgelser, hvorved Arbejdet med at udfinde passende Sammenlignings-Objekter er bleven betydelig lettet for mig.

sættes lig 100. Som man ser er Resultatet, at der næsten helt gennemgaaende er flere, ofte mange flere Kar pr. □ mm. i de smalle Aarringe end i de tilstødende brede. Da det her kun er dette gensidige Forhold, det kommer an paa, er det ligegyldigt, hvor i Stammen de undersøgte Prøver er tagne; de er faktisk tagne fra højst forskellige Steder baade hvad Højden over Jorden og Afstanden fra Marven angaar. En Ting vil det være rigtigt at henlede Opmærksomheden paa. Det kan ikke gaa an at benytte Tal som disse til deraf at drage en Middelværdi af Antallet af Kar pr. □ mm. hos Bog, thi da de store Marvstraaler med Flid er undgaaede, vil Antallet af Kar blive for stort. Beskaffenheden af de 3 undersøgte Træer, Forholdene, hvorunder de har vokset o. s. v., er her ligegyldigt, og derfor anføres der intet derom.

Men Forholdet bør naturligvis ogsaa undersøges hos andre Træer med spredtporet Ved, og til en Begyndelse undersøgte jeg *Salix alba* og *Populus ontariensis* efter den Metode at tælle Karrene direkte paa en Kvadratmillimeter midt i Aarringene, da disse var alt for brede til at den anden Maade kunde anvendes. I begge Træer fandtes Grupper af brede og Grupper af smalle Aarringe, hos Pilen var i den undersøgte Region de brede Aarringe gennemsnitlig 13 mm. brede, de smalle 2.7, hos Poplen var gennemsnitlig de brede Aarringe 11 mm. brede, de smalle 4. Resultatet stillede sig som ses af den lille vedføjede Oversigt. Enkelt-

Antal Kar pr. □ mm.	<i>Salix alba</i>	{ Brede Aarringe	48	53	47	41	44	50	36	40	43	42	41
		{ Smalle Aarringe	67	59	62	70	67	78	72	58	97	85	72
	<i>Populus ontariensis</i>	{ Brede Aarringe	26	38	30	40	29	29	35	30	38	34	33
		{ Smalle Aarringe	55	56	65	48	54	46	59	54	50	56	54

Tællingerne anføres, for at vise, at Resultatet ikke skyldes Tilfældigheder, og Forskellen i Kartætheden viser sig jo at være meget stor.

Efter denne foreløbige lagtlagelse undersøgte jeg 7 Træer og Buske med smaa over Aarringen spredte Kar efter samme Metode som de 3 Bøgestammer, men gennemgaaende færre Prøver, hvilket tildels blev nødvendiggjort ved Materialets Beskaffenhed. De undersøgte Planter var *Sorbus scandica* (20 Prøver), *Acer campestre* og *Cornus sanguinea* (hver 10), *Prunus domestica*, *Pyrus Malus*, *Salix daphnoides* og *Lonicera Xylosteum* (hver 5 Prøver). Resultatet er fremstillet paa Tavle 2, ganske paa samme Maade som for Bog, og udviser det samme, nemlig en betydelig større Kartæthed i de smalle end i de brede Aarringe. Man tør vel saa gaa ud fra, at dette er det almindelige Forhold.

Jeg kan nu hertil give den Oplysning, at denne Sætning er fremsat for lang Tid siden, nemlig af Adam Schwappach¹⁾, der udtaler: «Bei jenen Laubhölzern, bei welchen die Gefässe über den ganzen Jahrring gleichmässig verbreitet sind, ist

¹⁾ Das Holz unserer Waldbäume. Inaugural-Dissertation, München 1872.

Tavle 2.

Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	Aarrings- bredde i mm.	Antal Kar pr. □ mm.	pCt.
<i>Sorbus scandica</i>					<i>Cornus sanguinea</i>					<i>Pyrus Malus</i>				
4.22	75	1.28	100	133	1.20	80	0.92	108	135	2.33	97	1.58	108	111
3.42	83	1.50	125	151	1.75	51	0.97	70	130	1.55	131	0.75	146	111
1.50	87	1.08	119	137	1.88	59	0.90	57	97	1.63	123	1.08	119	97
4.12	91	1.87	103	113	1.67	62	0.90	64	103	3.23	107	2.40	158	148
1.50	95	1.08	122	128	2.20	55	1.60	60	109	3.12	108	2.38	128	119
1.30	106	0.92	150	141	1.00	61	0.60	101	166	<i>Prunus domestica</i>				
3.17	110	2.20	102	93	1.17	58	0.92	66	114					
1.70	113	0.93	131	119	1.47	58	1.13	71	122	1.83	161	0.85	218	135
1.67	81	0.76	144	178	1.55	57	0.92	69	121	0.62	207	0.30	235	111
2.17	81	1.50	83	99	2.37	52	0.83	72	138	0.62	202	0.30	232	115
1.13	132	0.75	153	116	<i>Acer campestre</i>					1.20	213	1.03	240	113
2.62	82	1.57	128	156						1.32	185	0.50	207	112
2.67	90	1.58	105	117						<i>Salix daphnoides</i>				
1.18	110	0.57	145	132	2.00	40	1.28	47	118	3.17	75	1.37	111	148
2.95	102	1.78	106	104	2.04	42	1.20	51	121	3.92	67	2.33	92	137
2.62	93	1.55	111	119	2.17	36	1.22	39	108	1.63	69	1.20	79	114
2.35	93	1.37	97	104	3.33	30	1.25	33	110	3.20	61	1.57	92	151
3.52	78	1.80	108	138	3.37	33	1.33	49	148	3.67	74	2.57	100	135
2.04	85	1.58	128	151	3.38	33	1.33	54	164	<i>Lonicera Xylosteum</i>				
2.83	84	1.58	100	119	2.38	43	1.20	57	133	1.60	110	0.63	198	180
					3.33	42	0.87	55	131	0.85	161	0.52	221	137
					2.04	62	0.83	62	100	2.12	147	0.70	179	122
					1.43	50	0.80	54	108	1.52	135	0.87	159	118
										1.03	153	0.63	182	119

dieses Verhältniss nicht von so entscheidendem Einfluss, doch sind auch hier im Allgemeinen breite Jahrringe besser als schmale, weil die Gefässe in beiden Fällen ziemlich gleiche Weite haben, im ersteren Falle aber nicht so nahe zusammenstehen» (l. c. S. 25—26). Dette er imidlertid fremsat ganske uden Begrundelse, og da meget af det, der er meddelt i det nævnte lille Arbejde, er givet paa anden Haand, er det ikke ganske klart, om den nævnte Iagttagelse skyldes Forfatteren selv. Den har i alt Fald ingen Indgang fundet, og i 1891 skriver ROB. HARTIG¹⁾: «Bei der Rothbuche hat die Ringbreite an sich keinen Einfluss auf die Holzgüte, da, wie

¹⁾ Lehrbuch d. Anat. u. Physiol. der Pflanzen, 1891 S. 283.

Fig. 98 zeigt, im breiten und schmalen Ringe die Organe etwa in derselben Weise vertheilt sind». Dette forholder sig ikke saaledes, og den Figur, hvortil der henvises, egner sig ikke til at give nogen Oplysning i denne Henseende.

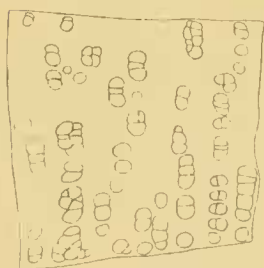


Fig. 30. *Alnus glutinosa*.
2 sammenstødende Aarringe.
35 G. Forst.

Det er nu ikke alle Træer med spredtporet Ved, der kan bruges til Bestemmelse af Kartætheden ved Aftælling. Dette gælder saaledes Birk og de Træer, der stemmer overens med denne deri, at Karrene tildels eller for største Delen er samlede gruppevis; foruden andre Vanskeligheder findes her ogsaa den, at Karrenes Størrelsesforhold er saa ubestemte. En Undersøgelse af Birk efter samme Metode som den først anførte, foreløbige Undersøgelse af Bog gav ogsaa et ganske ubestemt Resultat, og et Forsøg paa at bestemme Kartætheden haade hos *Betula verrucosa* og *B. odorata* efter den Maade, jeg ellers har anvendt, gav nok for begges Vedkommende flere Kar i de smalle Aarringe, men med saa store Svingninger og saa mange Uregelmæssigheder, at jeg ingen Vægt lægger herpaa og derfor heller ikke finder nogen Grund til at anføre Tallene. Derimod kan Forholdet belyses ved direkte Sammenstilling af en Afbildning henholdsvis af en bred og en smal Aarring, saaledes som det er sket i hosstaaende Billede af El, af hvilket det vil fremgaa, at Karrene fylder betydeligt mere i den smalle Aarring end i den brede Naboring. Ellen stiller sig i Henseende til Karrenes Gruppering omtrent som Birk, naturligvis bortset fra Dannelsen af de falske Marvstraaler, der ikke kommer i Betragtning her. Aarringene er af et vel vokset Træ.

Jeg gaar dernæst over til at omtale disse Forhold for Naaletræernes Vedkommende, idet jeg gentagende minder om, at det er Naboringe, eller i alt Fald tæt ved hverandre liggende Ringe, der er Tale om. Jeg har havt bedst Adgang til Materiale af Rødgran, og det nærmest følgende gælder denne. For at kunne bedømme Forskellen i Bygning mellem 2 Aarringe eller Grupper af Aarringe, for saa vidt det faar Betydning for Vægtfylden, har jeg taget Hensyn til 2 Forhold, Elementernes Størrelse, rettere deres Udstrækning i radial Retning, hvilket jeg har udtrykt ved

deres Antal pr. Millimeter (i Radius), og Procentmængden af tykvæggede Celler. Nu er dette sidste jo et meget ubestemt Begreb, og navnlig lader det sig her hos Rødgran ikke ret vel gøre at forsøge at fastslaa Forholdet mellem Vaarved og Høstved; dertil er Overgangen i Reglen alt for jevn og umærkelig. Jeg har derfor

valgt en anden Fremgangsmaade, der er mere omstændelig, men giver et sikrere Resultat. Jeg har talt, hvor mange Trakeider i Hostveddet der ligger udenfor den inderste Fællesvæg, hvis radiale Diameter er lig med eller større end den radiale Diameter af den udenfor liggende Trakeides Lumen¹⁾, det vil altsaa sige, hvor Lumen i radial Retning ikke er videre end den fælles Trakeidevæg. Disse har jeg i Tabellen kaldt «Tykvæggede Trakeider», og dette Begreb faar derved en ganske bestemt Betydning. Selfølgelig er dette kun en Tilnærmelse til det rigtige, thi det har jo ogsaa meget at sige, hvorledes det Trakeidevæv arter sig, der ligger længere inde i Aarringen, men det er i alt Fald et Forhold, der maa have en væsentlig Betydning for Kvaliteten. Hvad det andel angaar, Antallet af Trakeider pr. Millimeter,

Tavle 3. *Picea excelsa* fra Geel Skov.

Tracts Nummer	Det undersøgte Steds Højde over Jorden i Meter	Aarringenes Nummer, talt indenfra	Aarringens eller Aarringenes Tykkelse i mm.	Antal Trakeider pr. Radius	Deraf beregnet Antal Trakeider pr. mm.	Antal tykvæggede Trakeider	Procentmængden af de tykvæggede Trakeider
I	1.3	18	2.50	70	28.0	16	22.9
		19+20	2.50	82	32.8	20	24.4
	4.0	13	4.00	114	28.5	11	9.7
		14+15					
		+16	4.00	146	36.5	27	18.5
	12.0	20+23	4.27	120	28.1	18	15.0
		21+22	2.80	82	29.3	16	19.5
	20.0	20+24	6.00	130	21.7	14	10.8
		21+23	4.27	100	23.4	20	20.0
II	1.3	22+23	4.67	140	30.0	18	12.9
		25-28	4.80	144	30.0	25	17.4
	4.0	8	4.00	120	30.0	10	8.3
		9+10	4.00	130	32.5	16	12.3
	12.0	13	2.20	73	33.2	12	16.4
		14	1.47	52	35.4	9	17.3
	20.0	18	3.80	114	30.0	15	13.4
		19	2.50	85	34.0	13	15.3
III	1.3	44+45	3.00	92	30.7	12	13.0
		40-43	3.53	110	31.1	34	30.9
	4.0	18+19	3.80	117	30.8	8	6.8
		20+21	2.87	88	30.7	18	25.0
	12.0	53	2.67	72	27.0	12	16.7
		54+55	2.20	72	32.7	18	25.0
Tracts Nummer	Det undersøgte Steds Højde over Jorden i Meter	Aarringenes Nummer, talt indenfra	Aarringens eller Aarringenes Tykkelse i mm.	Antal Trakeider pr. Radius	Deraf beregnet Antal Trakeider pr. mm.	Antal tykvæggede Trakeider	Procentmængden af de tykvæggede Trakeider
IV	1.3	57+58 +60 59+61 +62	5.00	147	29.4	40	27.2
	4.0	52-54 49-51	5.30	155	29.2	32	20.7
	12.0	18+19	3.73	120	32.2	16	13.3
		20-22	2.00	70	35.0	15	21.4
	20.0	15	1.67	50	29.9	9	18.0
		17	1.00	37	37.0	14	37.8
V	1.3	43+44 41+42	1.00	140	35.0	7	5.0
	4.0	27	2.00	62	31.0	11	17.7
		28	1.27	40	31.5	7	17.5
	12.0	30+31	4.67	135	28.9	12	8.9
		33+34	2.87	88	30.7	14	15.9
	20.0	10	3.67	122	33.2	7	5.7
		11	1.47	64	43.5	1	6.3

¹⁾ Der fandtes en lille Bygningsanomalie, der har influeret paa Resultatet.

¹⁾ Undertiden hænder det, at Vægtykkelsen atter aftager udefter, at der altsaa ligesom dannes Bælter (slg. Afsnittet om falsk Aarringsdannelse). Saadanne Tilfælde er undgaaede her.

Tavle 4. *Picea excelsa* fra Gausdal og Lillehammer.

Træets Nummer	Aarrings- Nummer talt udenfra	Aarrings- Tykkelse i mm.	Antal Trakeider pr. Radius	Deraf beregnet Antal Trakeider pr. mm.	Tykvægede Trakeider	Procentmængden af tykvægede Trakeider
I	4+8	1.40	46	32.9	9	19.6
	3+7	0.80	29	36.3	7	24.1
	16+17	2.33	88	37.7	10	11.4
	13+14	1.00	34	34.0	5	14.7
II	8+9+10	3.20	100	31.3	18	18.0
	5+6+7	2.00	66	33.0	14	21.2
III	10	0.87	23	26.4	4	17.4
	9	0.67	19	28.4	4	21.1
IV	20+22	2.00	60	30.0	9	15.0
	19+21	1.47	50	34.0	10	20.0

Træets Nummer	Aarrings- Nummer talt udenfra	Aarrings- Tykkelse i mm.	Antal Trakeider pr. Radius	Deraf beregnet Antal Trakeider pr. mm.	Tykvægede Trakeider	Procentmængden af tykvægede Trakeider
V	4+6	3.60	100	27.8	8	8.0
	5+7	2.55	68	26.7	10	14.7
VI	4+6	2.53	72	28.5	9	12.5
	3+5	1.80	51	30.0	8	14.8
VII	4	4.67	124	26.6	10	8.1
	5	3.00	82	27.3	8	9.8
VIII	7+8	4.13	140	33.9	28	20.0
	10+11	1.87	68	36.3	22	32.4

Tavle 5. *Picea excelsa*
fra Stendalgaards
Plantage.

Middel- Aarrings- bredde i mm.	Vægtfylde
1.79	0.58
4.00	0.44
1.57	0.55
2.21	0.48
4.33	0.43
2.87	0.45
1.27	0.55
3.33	0.46
1.00	0.50
3.00	0.47
3.44	0.45
2.00	0.55
2.35	0.52
4.60	0.45
2.13	0.50
Middel	
2.12	0.52
3.94	0.45
1.91	0.51

er det ret indtysende, at jo flere der findes, desto fastere bliver Veddet, andre Forhold lige.

Tavlen 3 giver Resultatet af Undersøgelsen af 5 Granstammer, af hvilke de 4 er undersøgt i 4 forskellige Højder, den ene kun i 3. Materialet skriver sig fra Geel Skov. At Undersøgelsen er foretaget i forskellige Højder af Stammerne, har i og for sig ikke noget at sige, da det egentlig kun kom an paa at faa et Antal tæt ved hverandre liggende brede og smalle Aarringe til Sammentigning. For hver Skive findes 2 Rækker af Angivelser, den øverste for de forholdsvis brede, den nederste for de smalle Aarringe. Størst Interesse har den sidste og den tredjesidste Kolonne, hvor henholdsvis Trakeide-antallet pr. Millimeter og Procentmængden af tykvægede Trakeider er angivet; navnlig dette sidste Forhold stiller sig i høj Grad til Gunst for de smalle Aarringe. For Antallet af Trakeider pr. Millimeter er der en stadig, men ikke meget betydelig Overvægt. Alt i alt bekræftes dog Sætningen, at de smallere Aarringe har det bedre Ved, eller, om man vil udtrykke sig forsigtigere, tyder de smalle Aarringes større Antal tykvægede Trakeider paa en betydeligere Vægtfylde.

Det samme fremgaar af Tavle 4, der skyldes Undersøgelsen af Vedpropper, tagne med det Presslerske Tilvækstbor 1896 i Granskove ved Gausdal og Lillehammer i Norge. Der findes Prover af 8 Træer, af det med Nr. 1 betegnede 2, ellers kun 1 af hvert Træ. Den eller de bredere Aarringe staar øverst, den eller de smallere nederst.

Tavle 6. *Pinus silvestris*, 3 Træer.

I.					II.					III.				
Aarringens Bredde i mm.	Hostveddets Bredde i mm.	Hostvedprocent	Antal Trakeider pr. Aarrings- bredde	Antal Trakeider pr. mm.	Aarringens Bredde i mm.	Hostveddets Bredde i mm.	Hostvedprocent	Antal Trakeider pr. Aarrings- bredde	Antal Trakeider pr. mm.	Aarringens Bredde i mm.	Hostveddets Bredde i mm.	Hostvedprocent	Antal Trakeider pr. Aarrings- bredde	Antal Trakeider pr. mm.
1.95	0.50	26	60	31	2.80	0.85	30	83	30	2.25	0.85	38	67	30
1.55	0.70	45	54	35	1.50	0.48	32	48	32	1.45	0.80	55	48	33
3.10	0.70	21	94	28	2.50	0.60	24	75	30	1.85	0.65	35	59	32
1.85	0.60	35	59	32	1.75	0.70	40	59	34	1.25	0.50	10	38	30
2.45	0.45	18	67	27	1.65	0.85	52	53	32	2.65	1.25	47	82	31
1.85	0.55	30	57	31	1.05	0.40	38	33	31	1.75	1.15	66	58	36
3.55	0.55	15	107	30	2.25	0.55	24	73	32	3.65	1.00	27	110	30
1.90	0.55	29	60	32	1.60	0.50	31	53	33	1.85	0.55	30	57	31
2.50	1.05	42	67	27	2.75	0.65	24	88	32	2.20	1.10	50	72	33
1.45	0.60	41	47	32	2.15	0.65	30	68	32	1.20	0.80	67	40	33
2.40	0.75	31	64	27	2.75	0.55	24	85	31	2.15	1.25	58	71	33
1.50	0.70	47	43	29	2.10	0.75	36	67	32	1.80	1.20	67	60	33
1.55	0.45	29	45	29	2.00	0.85	43	61	30	3.00	1.15	38	93	31
0.95	0.35	37	29	31	1.25	0.50	40	39	32	0.95	0.70	74	40	42
1.85	0.50	27	56	30	1.40	0.60	43	48	34	2.30	0.65	28	75	33
0.90	0.35	39	33	34	1.00	0.48	48	34	34	0.80	0.30	37	31	39
1.85	0.55	30	48	26	2.75	1.25	45	77	28	2.50	1.00	40	73	29
1.15	0.30	26	30	26	2.00	1.20	60	64	32	1.60	1.00	62	50	31
3.90	0.80	21	100	26	5.40	0.85	16	156	29	2.85	0.90	32	86	31
1.60	0.50	31	52	33	2.65	0.65	25	87	33	2.10	1.15	55	73	35

Skønt jeg ellers ikke kommer ind paa Vægtfyldebestemmelser her, skal jeg dog anføre en enkelt Undersøgelse, som jeg gjorde, fordi der just tilbød sig dertil egnet Materiale, nemlig paa en ældre Rødgran fra Stendalgaards Plantage¹⁾ med en meget betydelig Diameter af Stammen. Veddet havde i den undersøgte Skive, hvis Højde over Jorden jeg har forsomt at notere, et indre og et ydre smalringet og et mellemliggende bredringet Parti. Udsnittene er derfor hver delt i 3 Stykker og undersøgt med Hensyn til Middel-Aarringsbredden og Vægtfylden, og da de smalringede Stykker ligger baade udenfor og indenfor det bredringede, kommer altsaa Afstanden fra Marven ikke i Betragtning. Der er undersøgt 5 Udsnit. Den inderste Del staar i hver Gruppe øverst, den yderste nederst. Resultatet, der findes i Tavle 5, bekræfter, at det smalringede Ved er det vægtfyldigste.

Foruden af Rødgran, som jeg hidtil har omtalt, har jeg havt godt Materiale

¹⁾ Meddelt mig ved Hr. kgl. Skovrider WÖLDIKE.

til Undersøgelse af Skovfyr, af hvilket jeg har valgt 3 Træer til Belysning af disse Forhold. Da Overgangen fra Vaarved til Høstved hos denne er noget mere brat end hos Rodgran, har jeg ment, lige som andre har gjort, at kunne tage Sagen mindre omstændeligt, og mere direkte fastslaa Høstveddets Forhold til Aarringens Bredde. Dette er sket ved en Forstørrelse under Mikroskopet af 20 Gange. Resultatet er fremstillet i Tavle 6, hvor de 3 Træer er betegnede I, II og III, og giver i det Væsentlige en Bekræftelse af, hvad der var iagttaget hos Gran.

Aarringsbredde og Vedkvalitet, andre Tilfælde.

Vi vil derefter gaa over til at omtale de speciellere Forhold, hvor ikke Aarringsbredden i og for sig, men ogsaa andre Omstændigheder kommer i Betragtning, saaledes som omtalt S. 190—91.

Vi kan her først standse ved det Tilfælde, hvor vi har med den samme Aarring at gøre og med dennes Bygning i samme Højde af Stammen, men paa 2 modstaaende Sider. Det er en forlængst bekendt Sag, at Veddet kan have udviklet sig meget forskelligt baade i Henseende til Mængde og til Kvalitet paa 2 Sider i en Stamme eller en Gren, og at dette staar i Forbindelse med, at Stammen har antaget en heldende Retning eller er meget forskelligt beløvet til den ene og den anden Side eller er ensidigt paavirket af Vinden. Hos Naaletræerne, der navnlig har været undersøgte paa dette Spørgsmaal, er det saaledes paavist, at mens ellers den større Ringbredde giver det mindre vægtfyldige Ved, linder det modsatte i Reglen Sted i det nævnte Tilfælde. Dette maa vel anses for at høre til de Sætninger, der kan betragtes som fastslaaede, og som vi derfor ikke behøver at opholde os videre ved. Hosstaaende lille Afbildning illustrerer paa en ret anskuelig Maade, hvor stor Forskellen i Virkeligheden er eller kan være. I Sommeren 1894 tog jeg med det Preslerske Tilvækstbor en Vedprop ud fra hver Side af en kraftig, men ensidigt forgrenet Rodgran ved Gausdal. Aarringene var noget, men ikke meget tykkere paa den kraftigt grenede Side, derimod var de der meget fastere byggede. Aarringen fra 1893 var

i den stærkt beløvede Side	3½ mm. tyk	med 110 Trakeïder i Radius
- — tyndt — —	3 mm.	— — 82 — —

Forskellen i denne Aarrings Bygning fra den stærkt og fra den svagt beløvede Side er fremstillet i Figur 31. En direkte Sammenligning mellem Fig. 31 *a*, fra den stærkt beløvede Side, og Fig. 31 *b*, fra den svagt beløvede Side, viser tilstrækkelig tydeligt den store Forskel i Trakeïdernes Andel i Arealet. For yderligere at anskueliggøre dette har jeg, stærkere forstørret, afbildet Trakeïderne 16—20, talt udvendig fra, fra den tyndtløvede Side (*d*) og for de tilsvarende fra den modsatte Side (*e*)¹).

¹) Slg. hermed FRANK SCHWARZ, Anf. Skr. S. 249.

I de norske Fjeldskove træller man meget hyppig Tvillingtræer — ogsaa i vore Kulturskove forekommer saadanne, men sjældnere —, fremkomne ved at den oprindelige Hovedstamme paa et tidligt Tidspunkt er gaaet nd af Spillet og 2 Sideskud har rejst sig. Saadanne er i Reglen voksede svagere paa den Side, de vender imod hinanden. I, II og III i hosstaaende Tavle betegner 3 Tvillingtræer, Tvillingerne betegnes henholdsvis ved A og B, den stærkt grenede Side, som de vender fra hinanden, ved a, den svagt grenede Side, som de vender mod hinanden, ved b. Som man ser er Tilvæksten svagere i den Side, som Stammerne har vendt mod hinanden. Dog er dette neppe altid Tilfældet og det vilde have Interesse at faa rigeligere Undersøgelser herover fra Steder, hvor der er let Adgang til Materiale af denne Art. lagttagelser over kvantitativ og kvalitativ uens Udvikling af Veddet i modsatte Sider af Stamme og Grene foreligger fra Riegler, Emile Mer, Rob. Hartig, Metzger, Fr. Schwarz, Johs. Helms og andre.

Men det praktiske Kendskab til, at Veddet kan være forskelligt udviklet i de to modsatte Sider af en Stamme gaar langt tilbage, og nedenstaaende historiske Notitser kunde maaske have nogen Interesse.

MUSSCHENBROECK¹⁾ havde lagt Mærke til, at Veddet har sin største Fasthed i den Del af Stammen, der vender mod Øst. Dette passer meget godt med de moderne Forestillinger om Vindens Indflydelse paa Stammen.

Men allerede LINNÉ omtaler Lappernes Kendskab til saadanne Fænomener for Fyrrens Vedkommende med følgende Ord: «Solliciter quaerunt Lappones arborem hanc caudice nutantem, quæ ad ripas in paludibus sæpe reperitur, cum ligni pars terram spectans durior sit, Buxi instar, quod lignum Tioern, seu. Kioern vocant²⁾».

¹⁾ Introductio ad philosophiam naturalem. Lugduni Batavorum 1763, I. Bd. S. 409. Dette har jeg citeret efter Chevandier & Wertheim, oversat af Exner og optaget i dennes Die mechanische Technologie des Holzes I Bd. 1871.

²⁾ LINNÉ, Flora Lapponica 1737, S. 275.

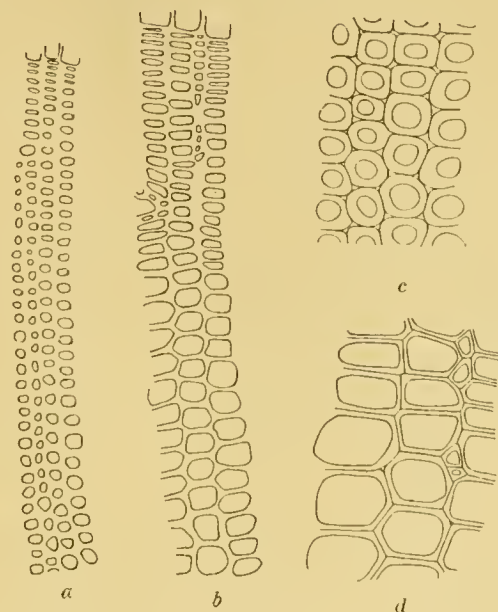


Fig. 31. *Picea excelsa*. a, b svagere forst., c, d 300 G. forst.

Tavle 7. De sidste 20 Aars Tilvæxt i Millimeter hos 3 Tvillingtræer, *Picea excelsa*, fra Gausdal.

	I.	II.	III.
A a	15	11	28
A b	11	11	24
B b . . .	7	7	28
B a	22	22	38

Dog, vi kan gaa længere tilbage og behøver ikke at standse ved Planteanatomiens Fædre, MALPIGHI og GREW, der i sidste Halvdel af det 17de Aarhundrede skal have omtalt disse Forhold. Den bekendte franske Filosof Michel Montaigne, der levede i det 16de Aarhundrede, omtaler i sin italienske Rejse¹⁾, at han i Pisa traf en Arbejder, *homme ingénieux à faire de beaux instruments de mathématique*», der berørte ham om, at alle Træerne havde lige saa mange Kredse, som de havde level Aar, og viste ham det i sit Værksted, hvor han arbejdede i Træ. «*Et la partie qui regarde le septentrion est plus étroite, et a les cerces plus serrés et plus denses que l'autre*».

Men vi kan endda gaa tilbage til det 15de Aarhundrede og standser da ved LEONARDO DA VINCI, hos hvem vi i nogle af Udgaverne af hans Værk *Trattato della Pittura* finder et Kapitel, som hedder «*Degli alberi e verdure*», hvor han foruden mange andre botaniske Iagttagelser, f. Eks. vedrørende Bladstillingsforholdene, meddeler, at Træernes Grene har lige saa mange Ringe indvendig som de er Aar gamle, at disse Ringe kan være af forskellig Tykkelse, hvilket tilskrives forskellige Fugtighedsforhold, samt endelig, at Stammernes Ringe er tykkere mod Nord end mod Syd, hvorfor Marven kommer til at ligge nærmere ved den sydlige Bark end ved den nordlige.

Gaar vi saa over til at betragte Aarringens Bygning i samme Træ og i samme Højde og samme Side af Stammen, men i forskellig Afstand fra Marven, saa anses det for fastslaaet, navnlig ved ROB. HARTIG'S talrige Undersøgelser, at Veddet hos Bog synker i Vægtfylde med Afstanden fra Marven. Dette maa jo afgøres ved Undersøgelsen af et meget stort Materiale. Men der er et enkelt Forhold, jeg skal berøre med et Par Ord her. Hartig har i sin Bog om Bogens Ved²⁾ to Afbildninger af Ved, dels af det, der er dannet i Træets ganske unge Alder, og dels af det, der er dannet, da Træet var gammelt, og den Forskel i Elementernes Størrelse, som viser sig her, tillægger han stor Betydning for Forklaringen af, at det i den unge Alder dannede Ved er meget vægtfyldigere end det, der fremkommer senere. Disse Afbildninger er gaaede over i hans Lærebog og er ogsaa reproducerede andetsteds, saa de derved er komne til at faa en vis paradigmatiske Betydning. Jeg har nu ved Betragtningen af mange Snit fra Regioner nærmere ved eller fjernere fra Marven faaet den Opfattelse, at Forskellen i Størrelse er langt ringere. Jeg skal henvise til omstaaende Fig. 32, hvor der findes afbildet Karfordelingen fra henholdsvis den 6—7de (a) og den 93—94de Aarring (b), samt, stærkere forstørret, Styrkevæv fra den 6te (c), og den 94de Aarring (d), fra en Højde af 7,5 Fod over Jorden. Karbilledet er taget fra Høstveddet af den ene Aarring og Vaarveddet af den følgende, og der er egentlig ingen Forskel at se paa Karrenes Vidde i disse to Afstande. Hvad Styrkevævet Elementer angaar, er de nok lidt videre i den 94de Aarring end i den 6te, men da Lysningerne ikke gør Indtryk af at være blevne

¹⁾ Journal du voyage de Michel Montaigne en Italie. A Rome et Paris, 1774. Vol. 3 p. 205.

²⁾ HARTIG u. WEBER, Das Holz der Rothbuche 1888, S. 21—22.

større med de Celler, hvori de linder, faar man mindst et lige saa substantielt Indtryk af dette Ved som af det fra den 6te Aarring. Vedelementernes Længde synes mig egentlig ikke at komme i Betragtning i denne Henseende, i alt Fald ikke til Ugunst for de længere. Ved en nøjere Betragtning af de Hartigske Billeder vil man forresten se, at det ikke saa meget er Omfanget af Styrkeækvets Elementer, der er

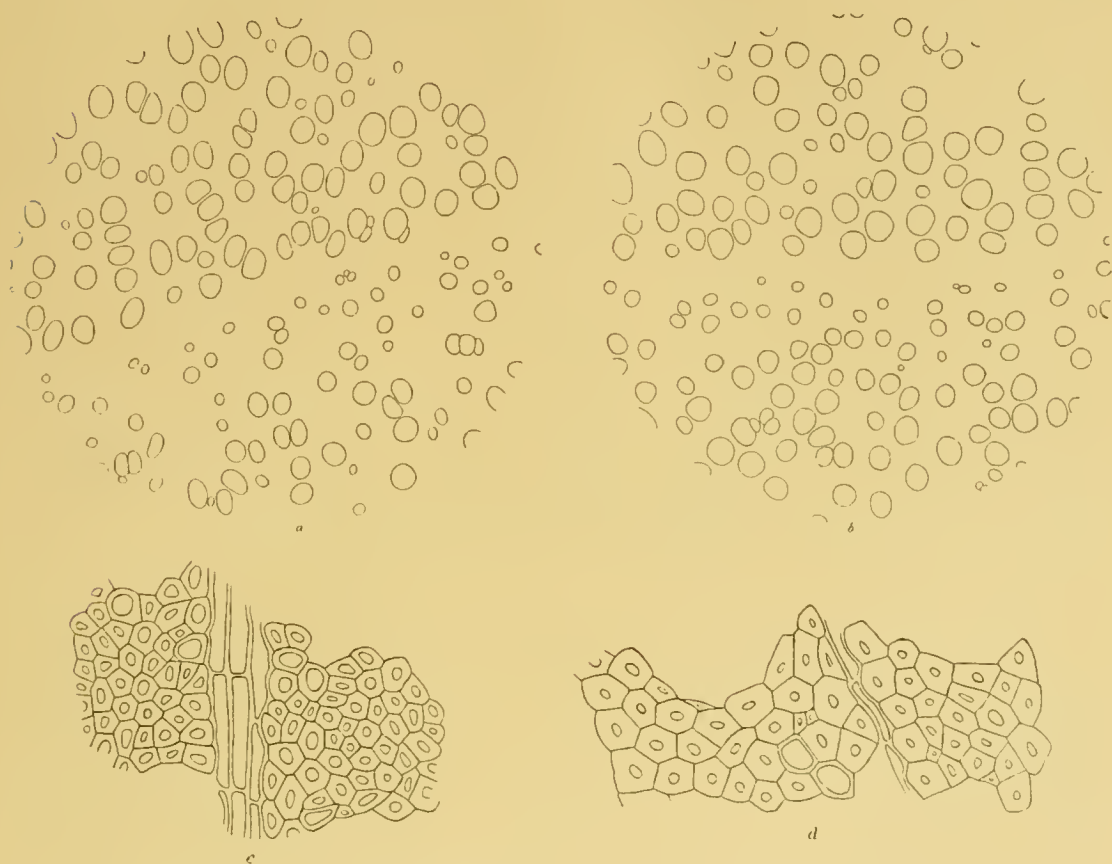


Fig. 32. *Fagus silvatica*. a, b 50, c, d 280 G. forst.

forskelligt, som det er Vidden af deres Lumina, og her gaar snarere hans og mine Figurer imod hinanden. Hvad Forholdet mellem Karvidden angaar, kunde der maaske gøres den Indvending, at Hartigs Billede er efter den 140de Aarring, mit efter den 93—94de. Men Karrenes Maksimalvidde skulde da forlængst være naaet, efter Hartigs Sigende fra den 60de Aarring¹⁾. Sandheden er vel den, at dette Forhold er stærkt varierende.

¹⁾ Rob. Hartig, Lehrbuch S. 286.

ROB. HARTIG gør gældende¹⁾, at hos Birk er Forholdet omvendt, men at det her ikke er Aarringsbredden i og for sig, der er afgørende for Veddets Kvalitet, men Alderen af den Trædel, hvor Aarringen er dannet; og kun af den Grund, at det Ved, der er dannet paa yngre Trædele, er lettere end det, der er dannet paa ældre Dele af Stammen, viser de i den yngre Alder dannede brede Ringe sig stoffattige.

Sammenligner man, siger Hartig, Veddets af de bredringede yngre Stammedele eller af Kærnen paa den nedre Del af Stammen med det smalringede Ved af Splinten fra Stammens nedre Del, saa springer 3 Forskelligheder i Øjnene, 1) er Tallet af Kar paa et bestemt Tværsnitsareal i brede Aarringe større end i smalle, altsaa omvendt af hvad der er Tilfældet hos Bøg, 2) er Vedtaverne i smalringet Ved mere tykvæggede end i Veddets af unge Aksedele, 3) viser Birkeveddet, jo nærmere ved Marvrøret, desto mer Strængparenkym. Den større Vægtfylde af det i en Stammedels højere Alder dannede Ved er altsaa begrundet i ringere Antal Kar, i Organernes større Tykvæggethed og i den svage Udvikling af Parenkym.

Ti Aar senere blev Birkens Ved underkastet en monografisk Bearbejdelse af OTTMAR STAUFFER²⁾. Dette Arbejde er udført under Rob. Hartigs Auspicer og følger egentlig ikke meget væsentligt til, som ses af nedenstaaende Opgørelse af Resultatet. Den for Birken fundne Regel, Vedvægtens Tiltagen indenfra udefter og ovenfra nedefter, forklares 1) af at «Libriformtaverne» tiltager i Tykvæggethed og dermed i Substansmængde, 2) af Parenkymdannelse Aftagen indenfra udefter og ovenfra nedefter, 3) af Karfladens Tiltagen pro Fladeenhed nedefra opefter.

Endelig har ogsaa J. HELMS³⁾ fundet, at Veddets Vægtfylde hos Birk tiltager fra Marven udefter.

Herom synes der altsaa at herske Enighed. Til den anatomiske Begrundelse er der nu et og andet at bemærke. Hartigs lagttagelse af, at der findes et ringere Antal Kar pr. Fladeenhed udadtil i Stammen, skulde have tabt sin Værdi ved at hans daværende Assistent, H. MAYR, paaviste, at de udadtil dannede Kar var saa meget desto større, hvilket Hartig selv senere⁴⁾ gør opmærksom paa. Dette berøres heller ikke af Stauffer. Det er nu rigtigt nok, at Karrene staar mindre tæt udadtil end i de i Træets unge Alder dannede Aarringe. Dog forekommer dette mig ikke let at kunne afgøres ved en Kartælling; thi her som i andre lignende Tilfælde, hvor Karrene staar gruppevis forenede, hvoraf følger, at de indre Kar i en Gruppe eller Række er meget mindre end de andre, giver Antallet af Kar kun en maadelig Forestilling om den Andel i Arealet, Kartværsnittene har. Tælle-Metoden maa her vige for den direkte Sammenligning, hvilket bedst sker ved en Aftegning ved Hjælp af Tegneprismet, og naar lagttageren da indestaar for, at Billedet er et Udtryk for

¹⁾ Untersuchungen aus d. forstbot. Institut zu München II, 1882, S. 60.

²⁾ Untersuchungen über spezifisches Trockengewicht, sowie anatomischen Bau des Holzes der Birke. Forstlich-naturwissensch. Zeitschrift I. Jahrg. 1892.

³⁾ Birken paa Tisvilde-Frederiksværk Distrikt. Tidsskrift for Skovvesen. Bd. IX B, S. 69.

⁴⁾ Allg. Forst- und Jagdzeitung 1884, S. 133.

det, der som Regel finder Sted, saa maa dette kunne gøre Fyldest. Hosstaaende Fig. 33 findes en Fremstilling af Kartætheden henholdsvis i den indre (a) og den ydre Del (b) af Stammen af en Birk i en Højde, hvor der fandtes 32 Aarringe. Forskellen træder saa tydeligt frem, at det ikke er nødvendigt at offere flere Ord herpaa. En kendelig Størrelseforskel mellem Karrene i den indre og den ydre Del er dog neppe eller i alt Fald kun meget svagt fremtrædende her. Det bliver der derimod, naar vi gaar endnu længere ind i Stammen. Det fremstillede Billede fra det indre er fra den 6te eller 7de Aarring (Fig. 33). 1 Fig. 34 er afbildet til indbyrdes Sammenligning Veddet fra den 31te Aarring (b) og fra den 2den eller 3dje Aarring (a). Her ses, at Karrene paa det sidste Sted ikke blot er tættere stillede, men tillige mindre (snevrere) end i Veddets ydre Del. Det er maa ske vanskeligt at skønne, hvorvidt disse 2 Forskelligheder vejer hinanden op eller ikke; dog forekommer det mig, at Veddet fra den ydre Del gør det mest substantielle Indtryk.

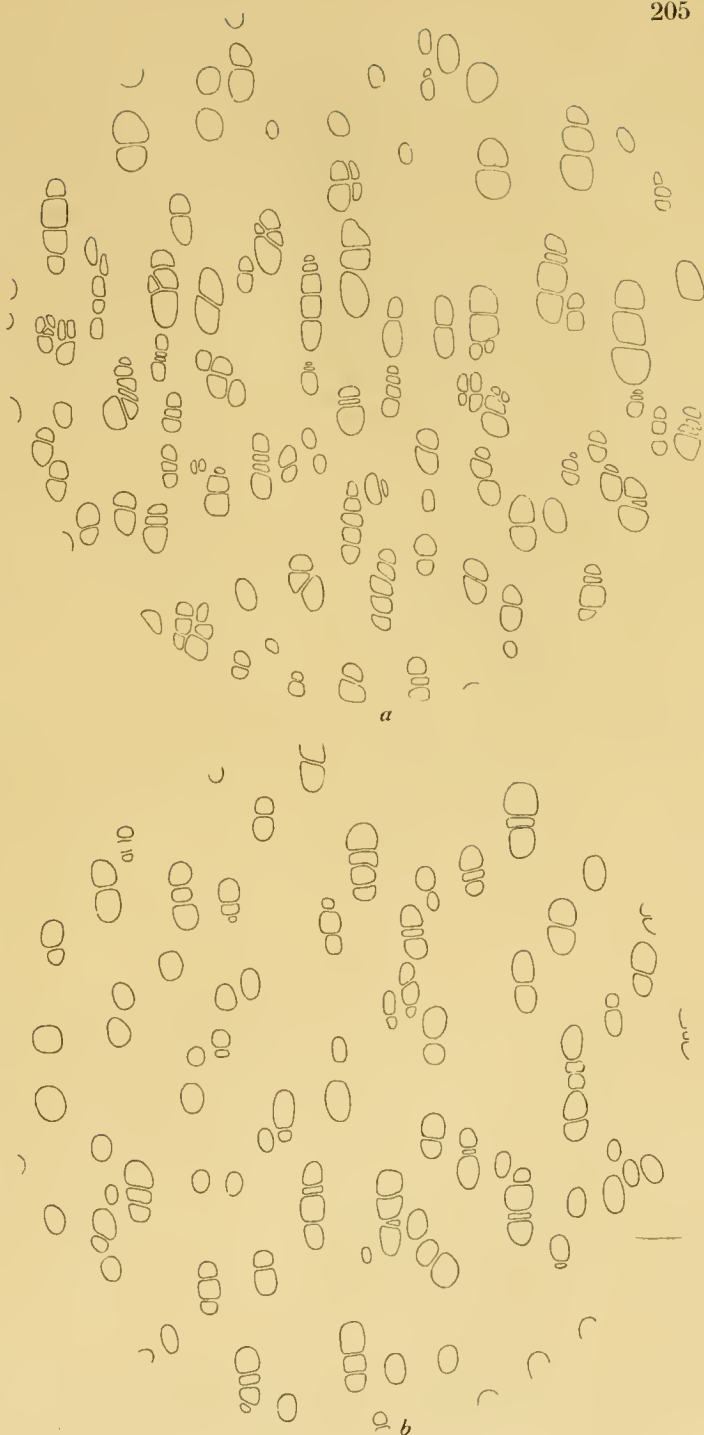


Fig. 33. *Betula odorata* 45 G. forst.

Saa kommer Vedtavernes (eller Trakeidernes, hvad man nu vil kalde dem) Forhold i Betragtning. Det er ganske sikkert, at de er mere tykvæggede i Veddets ydre end i dets indre Del¹⁾. Da dette baade er fremhævet med tilstrækkelig Præcision og af Stauffer oplyst ved en Afbildning, er der for saa vidt ikke Grund til at dvæle videre herved. Det ene af de to Billeder hos Stauffer, der ved at stilles ved Siden af hinanden skal anskueliggøre Forholdet, er, som Forfatteren selv gør opmærksom paa, enkelte Steder ikke helt korrekt tegnet, men de to Billeder illustrerer alligevel ganske godt Forskellen i Strukturen.

Hvad saa endelig Parenkymets Andel i Vedmassen angaar, skulde det interessere mig at vide, paa hvilken Maade Hartig og Stauffer er komne til deres Resultat.

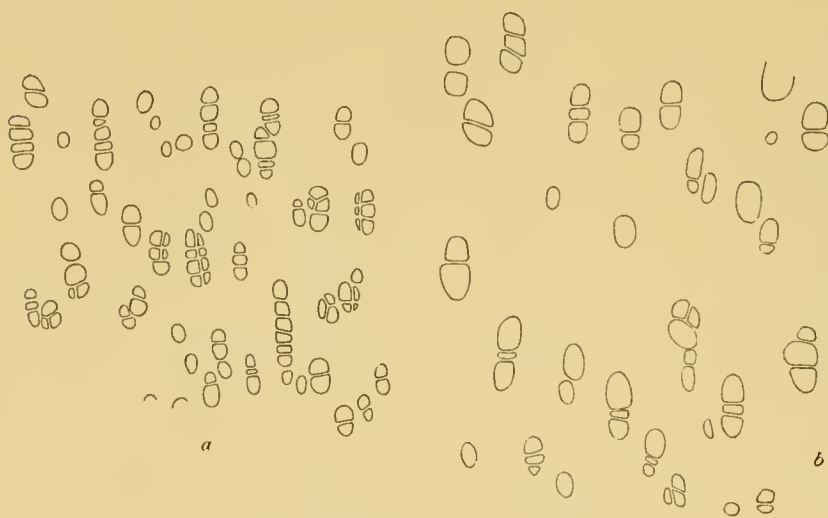


Fig. 34. *Betula odorata*. 45 G. forst.

I Tværsnitsbilledet træder nemlig Parenkymcellerne ikke stærkt frem i Modsætning til Veddets Styrkevæv. Det vil sige, der skal meget fine Snit og stærk Forstørrelse til for at kunne kontrollere det, men netop derved bliver det vanskeliggere at faa et Overblik. En anden Sag er det,

hvor disse Parenkymceller er stivelseførende; der kan man efter Jodbehandlingen let ved svag Forstørrelse vurdere disse Cells omtrentlige Andel i Tværsnitsarealet over en større Flade, saaledes som i Stammens øverste Del. Men i Stammens nederste Del, hvor vi har de mange Aarringe, og hvor altsaa Sammenligningen skulde foretages, der findes ingen Stivelse. Tydeligst træder Modsætningen mellem Parenkymet og det omgivende Væv frem i det radiale Længdesnit, men dette egner sig ikke til at give Oversigt over ret meget ad Gangen. Efter de Undersøgelser, jeg har anstillet, forholder det sig imidlertid rigtigt; der er sikkert mere Parenkym i de indre end i de ydre Aarringe²⁾.

¹⁾ SANIO, Vergleichende Untersuchungen über die Zusammensetzung des Holzkörpers, Bot. Zeitung 1863 S. 396-97, omtaler, at „die Holzzellen“ hos Birk tiltager i Størrelse indenfra udefter.

²⁾ I to Punkter, foruden hvad der angaar Spørgsmaalet Trakeide eller Vedtave, tager Stauffer Afstand fra H. Mayr. Stauffer holder gennemgaaende de ved Vegetationsperiodens Slutning dannede flad-

Den samme Stamme af *Betula odorata* benyttede jeg til en Undersøgelse af Veddets Vægtfylde. Udsnittene er hver delt i 3 Stykker, *a.* nærmest Marven, *b.* i Midten og *c.* ud mod Barken. Med Undtagelse af Skiverne 4 og 10 er der af hver Skive taget 2 Udsnit, nogenlunde lige over for hinanden. Resultatet, som ses af Tavle 8, afgiver en Bekræftelse paa de tidligere Iagttagelser, at Birkens Vægtfylde stiger indenfra udefter.

Dernæst kommer vi til at betragte — ligeledes særligt med Hensyn til den anatomiske Begrundelse —, hvorledes det stiller sig med den samme Aarring i samme Side, men i forskellig Højde af Træet. Hvad dette angaar, har der efterhaanden fæstnet sig en bestemt Opfattelse, nemlig, at Veddets i det ikke undertrykte og vel ernærede Træ aftager i Vægtfylde fra Stammens Grund opeller indtil det Sted, hvor Kronen begynder.

Det er, som vi senere skal se, et gammelt kendt Forhold. Rob. HARTIG er den første, der har forsøgt at belyse det ved Undersøgelse af Veddets Bygning, og hans Begrundelse — for Løvtræernes Vedkommende — gaar ud paa følgende: Under de nævnte Betingelser, nemlig at vi har at gøre med Træer med en god Kroneudvikling, aflæser Aarringens Areal opeller, mens Antallet af Kar bliver omtrent det samme; disse maa altsaa foroven rykke tættere sammen, og dette giver naturligtvis Ved med ringere Vægtfylde.

Tavle 8. *Betula odorata*. Vægtfylde.

Skivens Nummer	Skivens Alder	Højde over Stødet i Fod	<i>a</i>	<i>b</i>	<i>c</i>
1	42	0	0.52 0.50	0.60 0.64	0.67 0.67
1	32	6	0.50	0.58	0.64
7	31	12	0.49 0.45	0.56 0.57	0.61 0.63
10	29	18	0.48	0.58	0.63
13	27	24	0.50 0.57	0.57 0.63	0.64 0.65
16	25	30	0.53 0.52	0.58 0.59	0.61 0.62
19	23	36	0.53 0.52	0.55 0.56	0.59 0.58

Da dette anatomiske Spørgsmaal aldrig har været behandlet i vor egen Litteratur, var jeg interesseret i selv at gaa det efter, saa meget mere, som jeg ikke har været i Stand til at finde, hvorledes Rob. Hartig har anstillet de Iagttagelser, der ligger til Grund for den Sætning, at Karrene staar tættere imod Spidsen af Bullen, den Del af Stammen, der ligger neden for Kronen, end ved Stammens Grund. Med den store Variabilitet, der overhovedet er i Karrenes Tæthed i en og samme Stamme, ogsaa i samme Højde og samme Side af Træet, forekom det mig lidt misligt at sammenligne indbyrdes saa smaa Arealer som Kvadratmillimetre med saa

trykte Elementer for „Libriformfasern“ og „har aldrig iagttaget“, at Parenkymet skulde være ordnet i tangential Rækker. Parenkymet viser just Tilbøjelighed til at staa i tangential Rækker, for saa vidt det, hvad der saa hyppigt er Tilfældet i Træernes Ved, som et enkelt Cellelag spænder fra Marvstraale til Marvstraale. Og de fladtrykte Elementer, der dannes ved Aarringens Afslutning, er netop meget ofte stivelseførende Parenkym.

stor vertikal Afstand. Hvis nemlig Karrenes Tæthed svinger stærkt endogsaa i den samme Aarring i samme Højde, men paa en Bue med en Tangent af blot nogle faa Centimeter, vilde en Sammenligning med det tilsvarende Areal højt oppe tabe betydeligt i Vardi, da det er umuligt at sikre sig disse Arealer nøjagtigt i samme lodrette Linje. Alene eventuelt stedfundne Vridninger af Veddet vilde her gribe forstyrrende ind.

Jeg har derfor fundet det rigtigst, forinden jeg har sammenlignet Kartætheden i Stammens øvre og nedre Del, at undersøge Variationen i Karrenes Antal pr. $\square$ mm. paa en Strækning af nogle faa cm. i samme Højde i en Aarring.

Den første Undersøgelse paa Bøg — 10 Arealer paa en Strækning af 3 cm., Kartallet reduceret til at svare til en $\square$ mm. — gav følgende Antal Kar: 89, 85, 81, 80, 80, 78, 78, 78, 77, 72. Aarringens Nummer, Skivens Højde over Jorden o. s. v. er ligegyldigt og derfor ikke noteret. Aarringens Bredde var omtren 2,13 mm. Det foreliggende Resultat maa siges at antyde en vis Ensartethed i Karrenes Tæthed,

Tavle 9. *Fagus sylvatica*.

Træets Nummer	Antal Kar pr. $\square$ mm.		
	Højde over Jorden i Fod		
	4.15	42.5	57.5
I	104	112	120
II	91	121	140
III	75	92	107

naar man tager Hensyn til, hvor meget den ellers svinger. En anden Undersøgelse, ligeledes fra Bøgestammens nedre Del, af 10 Arealer, beliggende paa en Bue med en 5 cm. lang Tangent og hvor Aarringsbredden var omtrent 2 mm., gav følgende Variation: 93, 88, 88, 84, 84, 82, 82, 77, 77, 76, altsaa samme Variationsvidde som i foregaaende Tilfælde. En tredje Undersøgelse fra en meget højere beliggende Del af en Bøgestamme — Aarringen knap $2\frac{1}{2}$ mm. bred, Tangenten 4 cm. — gav: 115, 114, 112,

108, 108, 107, 107, 106, 104, 101. Disse Variationer, altsaa i en tangential Strækning af 2—5 cm., er ikke større end at man derefter nok tør indlade sig paa en Sammenligning af Kartætheden i forskellige Højder, hvortil allerede Differensen mellem den sidste og de to første af disse Iagttagelser opfordrer.

Jeg undersøgte 3 af de til min Raadighed stillede Bøgestammer i 3 forskellige Højder og mød samme Verdenshjørne. Resultatet er fremstillet i hosstaaende lille Oversigt, Tavle 9, hvor Tallene for Træerne I og II er Middeltal af 10 Undersøgelser, for III af 5, saa at Oversigten altsaa er bygget paa 75 Enkeltundersøgelser, foretagne paa samme Maade som jeg tidligere har angivet. For alle 3 Træers Vedkommende findes en ret betydelig Stigning i Kartætheden op efter. Dette kan ogsaa direkte ses, mest iøjnefaldende naturligvis ved at stille Billeder, tagne fra de forskellige Højder, ved Siden af hinanden.

Fig. 35 viser Karfordelingen i den indre Del af Aarringen, henholdsvis fra 4,15 (a) og 57,5 Fods Højde (b) i Bogen Nr. II, og det er let at se, at Karrene staar hverandre betydelig nærmere i den store Højde end forneden. Tillige ses af Afbildningerne, at Karrenes Vidde er den samme foroven og forneden.

Denne Undersøgelse har jeg egentlig kun taget mig for af Trang til ved Selvsyn at overbevise mig om Rigtigheden af Robert Hartigs Angivelser med Hensyn til Karrenes Tæthed i forskellige Højder, og disse bekræftes altsaa fuldstændigt.

Denne Maade at undersøge Veddets Kvalitet paa er naturligvis noget vidtløftig og har jo navnlig sin Interesse derved, at den skulde bidrage til Forstaaelsen af hvad det er for Bygningsforhold, der betinger den forskellige Vægtfylde. Naar vi siger, at tæt Karstilling betinger en ringere Vægtfylde, er det under Forudsætning af, at andre Forhold er lige. Den forholdsvis ringere Mængde af Styrkevæv kunde jo opvejes ved, at dets Elementer havde saa meget større Vægtykkelse. Noget

saadant lod sig i det foreliggende Tilfælde ikke direkte paavise. Paa den anden Side vil jeg dog ikke tilbageholde den Bemærkning, at jeg med Hensyn til Vægtfylden har undersøgt 5 Bogestammer, deriblandt de 3 ovennævnte, med det Resultat, at der ikke var nogen udpræget Stigning i Vægtfylden nedefter. Det samme var Tilfældet med den S. 207 omtalte Birk¹⁾, hvis Vægtfylde jeg bestemte i 11 forskellige Højder indtil 60 Fod over Stødet. Ogsaa HELMS er kommet til dette Resultat ved sine Undersøgelser over Birk²⁾.

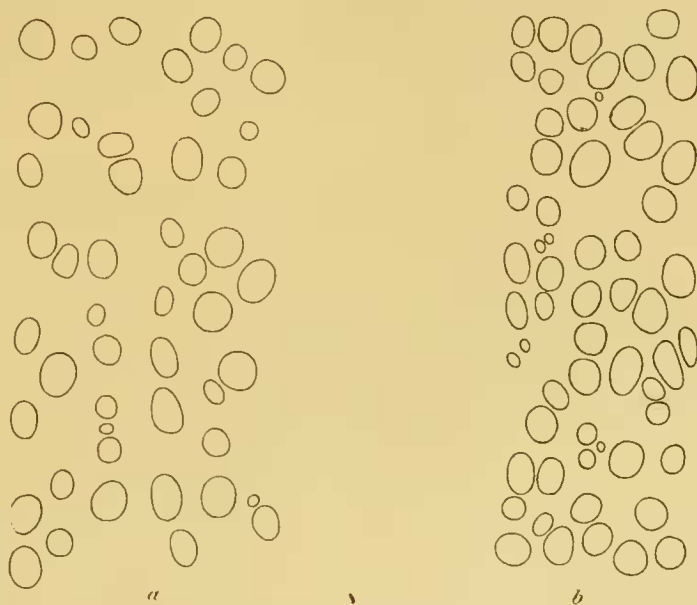


Fig. 35. *Fagus silvatica*. 80 G. forst.

Som ovenfor antydet, er Kendskahet til, at Veddets Vægtfylde i den greneløse Stamme er større forneden end foroven, gammelt, og vi kan i alt Fald gaa tilbage til Midten af det 18de Aarhundrede, idet vi finder det ikke alene omtalt men bevist ved Forsøg af Duhamel du Monceau. I et stort Arbejde over Veddets Anvendelse³⁾ beskriver han sine Forsøg over Veddets Vægt hos Eg i forskellige Højder. Først forsøger han ved at sætte en Planke, der er savet ud af Stammen saaledes, at den naar fra Marv til Bark, i Vand; men da denne Metode kun «d'une

¹⁾ I alt Fald i Kolonnen a. I b og c, altsaa ved den senere Tilvækst, er der jo nok nogen, om end uregelmæssig, Stigen i Vægtfylde nedefter, eller rettere nogen Forskel i Vægtfylden forneden og foroven.

²⁾ J. HELMS, Birken paa Tisvilde—Frederiksværk Distrikt. Tidsskrift for Skovvæsen Bd. IX B. S. 68.

³⁾ Duhamel du Monceau, De l'exploitation des bois, Paris 1764, S. 109 flg.

façon toute vague overbeviste ham om, at Veddets ved Foden vejede mere end mod Toppen, prøvede han paa en anden Maade. Han tog et 4 Fod langt Stykke af den mest rette Del af Stammen af en ung Eg i en Alder af 8—10 Aar, lod dette tildanne under Høvlen, saa det blev nøjagtigt lige tykt i hele sin Længde, delte det derpaa i 8 Stykker, hvert paa $\frac{1}{2}$ Fod, og vejede disse. Resultatet viste en regelmæssig Tiltagen i Vægt fra det øverste til det nederste Stykke. Forsøget blev foretaget i Oktober 1735. Dette Forsøg blev foretaget baade med Ved i grøn og med Ved i torret Tilstand samt paa et Træ af langt større Dimensioner, med samme Resultat¹⁾.

Spørgsmaalet Aarringsbredde og Vedkvalitet, naar der er Tale om Sammenligning mellem forskellige Træer, har jeg ikke havt Lejlighed eller Materiale til at komme ind paa; men det har ellers været Genstand for mange Undersøgelser og lagtlagelser, hvorom der navnlig maa søges Oplysning i den forstlige Literatur.

Karvidde og Aarringsbredde.

Tilbage staar nu med et Par Ord at berøre Spørgsmaalet om Karrenes Vidde i Forhold til Aarringens Bredde; det er i forbigaaende omtalt enkelte Steder i det foregaaende. En større eller ringere Tæthed af Karrene vil kun have Betydning for saa vidt Virkningen heraf ikke svækkes ved en større Udvikling i Vidde af de mindre tæt stillede Kar. Den radiale Bredde af Trakeiderne hos Naaletræerne kan ogsaa nævnes i denne Sammenhæng.

HUGO v. MOHL er vel den, der først har henledet Opmærksomheden paa, at Planternes kraftigere eller ringere Udvikling i Henseende til Dimensionerne har Indflydelse paa Størrelsen af deres Elementærorganer²⁾. Siden har navnlig ROB. HARTIG³⁾ gjort opmærksom herpaa, og fra den nyeste Tid har vi Undersøgelser herover af CIESLAR⁴⁾, der paaviser, at i en Stamme af Rødgran med meget stærk Tykkelsevækst er Elementerne større og Veddets derfor grovere end i en undertrykt Stamme med ringere Tilvækst.

WIELER⁵⁾ opstiller Spørgsmaalet, om der lader sig paavise et Forhold mellem Størrelsen af det radiale Trakeidegennemsnit og Ringens Bredde, og dette Spørgsmaal besvares for den eneste undersøgte Arts, Skovfyrrens, Vedkommende derhen, at et saadant Forhold virkelig er til Stede, idet et større Trakeidegennemsnit svarer

¹⁾ Iøvrigt kan her mindes om, at Kendskabet til disse Forhold gaar saa langt tilbage i Tiden, at vi endog finder det omtalt i et gammelt indisk Sagn (Pfeil. Krit. Bl. 43de Bd., 1ste Hæfte, 1860, S. 267).

²⁾ Botanische Zeitung 1862 S. 238.

³⁾ HARTIG u. WEBER, Das Holz der Rothbuche. S. 80.

⁴⁾ Qualität rasch erwachsenen Fichtenholzes, Centralbl. für d. gesammte Forstwesen, 1902, s. navnlig S. 373—76.

⁵⁾ WIELER, Ueber Beziehungen zwischen sekundärem Dickenwachsthum und Ernährungsverhältnissen der Bäume (Tharander Forstliches Jahrbuch Bd. 12, 1892, s. navnlig Side 96 og følgende).

til en større Ringbredde, vel at mærke ved Sammenligning af tilsvarende men forskelligt tykke Aarringe i forskellige Træer. Af Løvtræer har han undersøgt Karrenes Vidde hos Bøg med det samme Resultat. Wieler har ogsaa iagttaget større Kar i bredere Aarringe (samme Individ og uden at der er Tale om Ekscentricitet) hos *Vitis vinifera* og *Ampelopsis quinquefolia* (l. c. S. 113—14).

For de to modsatte Sider af ekscentrisk udviklede Organer har vi Undersøgelser over disse Forhold af KNY¹⁾ og R. HOFFMANN²⁾. Disse har iagttaget et større radiaalt Gennemsnit af Elementærorganerne paa den brede end paa den smalle Side. Enkelte herhen hørende Tilfælde er iagttagne af WIELER (l. c. S. 111) hos Ask og Birk.

FRANK SCHWARZ³⁾ meddeler Iagttagelser over Trakeïdernes Størrelse hos Skovfyr i brede og smalle Aarringe og har paavist, at «die Spätholztracheïden» gennemsnitlig er større, jo bredere Aarringen er, men at Vaartrakeïdernes Tiltagen i Størrelse ikke svarer til Aarringens Tiltagen i Bredde. Det er her en med ekscentrisk Marv forsynet Stammes Aarringe, der sammenlignes, henholdsvis fra «Tryk- og Træksiden».

Endelig kan specielt for Askens (*Fraxinus excelsior*) Vedkommende nævnes iagttagelser af Mohl, Sanio og Schneider. MOHL⁴⁾ har hos Ask fundet 1) at Karrene i Stammer med smalle Aarringe (1^{'''}) er videre end i andre Stammer med meget brede Aarringe (6—7^{'''}), 2) at Karrene i de smalle Aarringe staar i Vidde ikke kendeligt tilbage for dem i de ældre godt udviklede Aarringe i samme Stamme, og 3) at Karrene i de smalle Aarringe i mange Tilfælde er videre end i de brede i samme Stamme. SANIO⁵⁾ har 1) fundet, at Karrene i en Stamme med smalle Aarringe (14 Aar gammel, Stammen 15 mm. i Gennemsnit) er snevrere end i Stammer med brede Aarringe, og 2) markerer dette som en Afvigelse fra hvad Mohl har iagttaget. Hertil er at bemærke, at de af Sanio undersøgte smalle Aarringe er saa særdeles line, at Mohls «smalle», 1^{'''} brede, Aarringe i Sammenligning med dem snarere maa betegnes som brede. Endelig har SCHNEIDER⁶⁾ iagttaget, at 1) i Brysthøjde tiltager med Alderen Karrene i Antal og Vidde (S. 424) og 2) med Højden aftager de store Kars Gennemsnit afgjort (S. 425).

Disse ingenlunde udtømmende Litteratur-Notitser har jeg meddelt til Oplysning for hvem der maatte interessere sig for at gaa lidt nærmere ind paa disse Spørgsmaal. Selv har jeg søgt, naar Lejlighed har budt sig, at danne mig en Opfattelse af disse Forhold, dels i forskellige Træer, dels inden for en og samme Stamme.

1) KNY, Ueber das Dickenwachsthum des Holzkörpers in seiner Abhängigkeit von äusseren Einflüssen, Berlin 1882.

2) HOFFMANN, Untersuchungen über die Wirkung mechanischer Kräfte auf die Theilung, Anordnung und Ausbildung der Zellen beim Aufbau des Stammes der Laub- und Nadelhölzer. Sondershausen 1885 (Inauguraldissertation).

3) Dickenw. u. Holzqual. von Pinus silvestris. S. 255.

4) Botanische Zeitung 1862, S. 269—71.

5) Botanische Zeitung 1863, S. 398—99.

6) Forstlich-naturwissensch. Zeitschrift Bd. 5, 1896.

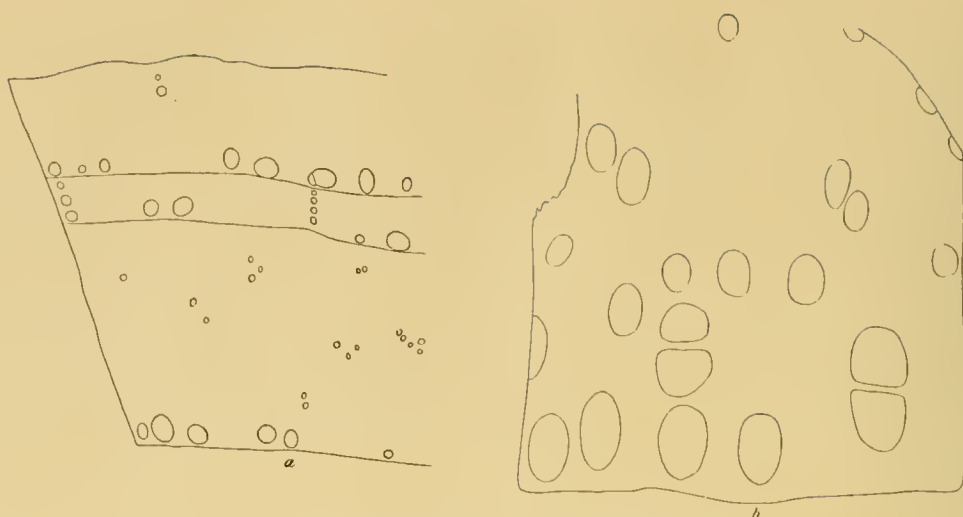


Fig. 36. *Fraxinus excelsior*, 47 G. forst.



Fig. 37.

Fagus silvatica, 52 G. forst.

Som Eksempler paa Forskel i Karrenes Vidde i smalle og brede Aarringe hos henholdsvis svagt og stærkt voksede Træer, kan jeg anføre følgende:

Ask (*Fraxinus excelsior*), 11-aarige Planter (1888—98), fra Grevskabet Bregentveds Skovinspektion, sendte ved Forstinspektør, Jægermester HAUCH. Planterne har staaet under tilsyneladende heldige Betingelser, men har af en ukendt Aarsag udviklet sig mærkværdig slet. Et Eksempel, 70 cm. høj, foruden 7 mm. tyk, viste ialt 10 Aarringe; de 3 yngste af disse er tegnede (a) til Sammenligning med en kraftig vokset Askegren, der indeholdt 13 Aarringe og var 82 og 74 mm. tyk; af disse er noget af en Aarring tegnet (b). De store Kar i den retarderede Ask var kun omtrent 0,056 mm. vide, de tilsvarende i den tykke Gren 0,104 mm. Dertil kommer, at de »store« Kar i de smaa Planter kun staar i en enkelt Kreds, mens de ellers staar i flere.

Bøg (*Fagus silvatica*). Her henvises til Fig. 37, der forestiller den 10de, altsaa yngste, Aarring af to 10 Aars gamle Bøge (fra Hardenberg ved Prof. Oppermann). b var 142 cm. høj over Kotedonerne og 14 mm. tyk foruden, a var 73 cm. høj med en Tykkelse foruden af 5 Millimeter. Forskellen i Karrenes Vidde er ret betydelig.

Eg (*Quercus pedunculata*). Fig. 38 *a* er af en meget lille Eg fra et af de jyske Hedekrat; den var omtr. 30 Aar gammel og havde en Veddiameter af kun 27 mm. Vaarveddets Kar $\frac{1}{20} - \frac{1}{8}$ mm. vide. Fig. 38 *b* er af en normalt vokset Eg, der i samme Alder havde naaet en Veddiameter af 154 mm. Vaarveddets Kar $\frac{1}{10} - \frac{1}{3}$ mm. vide.

Bævreasp (*Populus tremula*). Fig. 39 *b* er af et normalt vokset Træ, der i den undersøgte Region har 13 Aarringe og viser en Veddiameter af 14 cm. Billedet er taget fra en af de yderste Aarringe og indeholder dennes ydre Del. Fig. 39 *a* er af et svagt vokset Træ fra Grimstrup Krat, fra Stammens nedre Del, men over Stammefoden. Træet indeholder sammesteds nogle flere Aarringe end foregaaende og var 4 cm. i Veddiameter. Billedet omfatter næstyderste og noget af tredjedyderste Aarring. Forskellen i Karrenes Vidde er ikke særdeles betydelig, men dog stor nok til, at den let falder i Øjnene.

Det forstaar sig, at Sammenligninger af denne Art kun gælder inden for det samme morfologiske Organ. Rodveddet, der gennemgaaende har smallere Aarringe end Stængelveddet, har i Reglen betydelig videre Elementærorganer.

Vi vil til Slutning betragte Karrenes Vidde i brede og smalle Aarringe inden for den samme Stamme (Gren) i samme Højde, samme Side og tilnærmelsesvis samme Afstand fra Marven. Jeg har paa dette Spørgsmaal undersøgt følgende Træer: *Quercus pedunculata*, *Q. rubra*, *Ulmus campestris*, *Fraxinus excelsior*, *Hippophaë rhamnoides*, *Fagus sylvatica*, *Alnus glutinosa*, *Betula verrucosa*, *Corylus*

Avellana, *Salix daphnoides*, *Hedera Helix*, *Cornus sanguinea*, *Prunus Mahaleb*, *Tilia grandifolia*, *T. europaea*, *Rhamnus cathartica*, og har hos dem alle fundet Karrene lige vide i brede og smalle Aarringe. Undersøgelsen er foretaget paa den Maade,



Fig. 38. *Quercus pedunculata*. 50 G. forst.

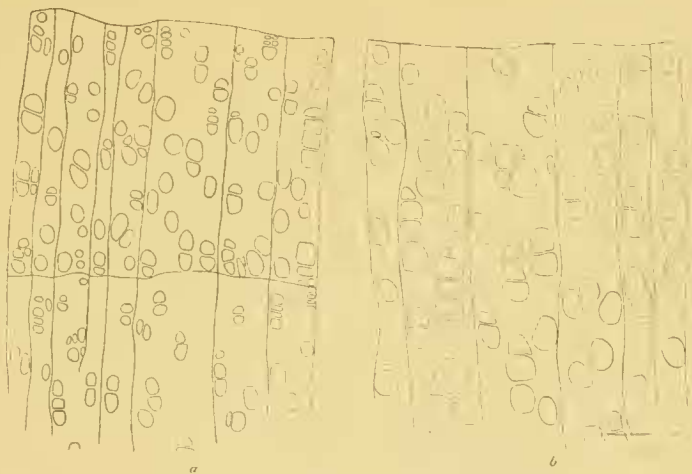


Fig. 39. *Populus tremula*. 50 G. forst.

at jeg med Tegneprismet under 100 Ganges Forstørrelse har aftegnet en Gruppe af Kar, henholdsvis fra en bred og en smal sammenstødende Aarring umiddelbart ved Siden af hinanden, og saaledes har kunnet sammenligne dem direkte.

Vil vi føre denne Betragtning over paa Naaletræernes Trakeïder, saa kunde et Blik paa Tallene i Kolonnen: Antal Trakeïder pr. Millimeter, i Tavle 3, Side 197, tyde paa, at Trakeïderne var — om end kun meget lidt — videre i de brede Aaringe end i de smalle, for saa vidt som der er færre af dem paa en Længdeenhed. Men dette kan forklares alene ud af den større Høstvedprocent i de smalle Aaringe. Jeg har paa en længere Strækning sammenlignet, lige som ovenfor nævnt ved Aftegning ved Hjælp af Tegneprismet, Tykkelsen af det Bælte, som de 5 først dannede Vaartrakeïder udgør, og har i de fleste Tilfælde, nemlig hos Rødgran, Ædelgran og Skovfyr, ikke kunnet se nogen Forskel, hvorimod jeg hos Lærk i nogle Tilfælde har fundet de 5 første Trakeïder noget videre i de brede Aaringe end i de smalle. Disse lagttagelser er dog noget ufuldstændige.

Men Karrenes Vidde synes altsaa i Naboringe og med de ovenfor tagne Forbehold ikke at variere med Aarringens Bredde.

N. Y. ACADEMY
OF SCIENCES

ON THE AGGLUTINATION
OF
BACTERIA

BY .

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KØBENHAVN
BIANCO LUNOS BOGTRYKKERI

1905

Introduction.

Since NICOLLE drew attention to the fact that the agglutination of bacteria by an agglutinating immune-serum depended upon the formation of a compound between the agglutinating body, or agglutinine, of the serum, and the agglutinable substance in the bacteria, and after BORDET and later Joos had proved that this agglutination would not take place unless a salt were present, it has been customary to regard the process as a direct or indirect consequence of the union of these three substances. Very various views, however, are held by different observers as to the precise nature of this union. Thus GRUBER, and NEUFELD, believe that it is a simple chemical combination; Joos, that it resembles the formation of a double salt; while BORDET states that the union is no more than a simple physical process of absorption, and that it brings about agglutination either directly or in consequence of a change in the molecular attraction between the bacteria and the fluid in which they are suspended.

The application of EHRLICH's side-chain theory and its terminology to the phenomena of agglutination has led to still further speculation as to the nature and mode of action of the specific agglutinines, that is to say, of those occurring in immune-sera. EHRLICH, WASSERMANN, and KIRSTEIN, regard agglutinines as receptors of the second order; BAIL believes them to be receptors of the third order. EISENBERG & VOLK appear to be uncertain whether they are receptors of the second order or of the third, and describe the agglutinines as composed of two molecular groups, the first a labile specific group causing agglutination, the second a more stable group that serves to unite the agglutinine to the bacteria that are to be agglutinated. Proceeding further, they state that an agglutinine can be converted partially or entirely into an *agglutinoid* by various physical or chemical agents, such as heat, acids, or alkalies; and they compare the agglutinoids to EHRLICH's toxoids. The discoveries of EISENBERG & VOLK, WASSERMANN, and others, go to shew that the agglutinoids fall into two classes, the proagglutinoids and the synagglutinoids; the former having an affinity greater than, the latter an affinity equal to, that of the agglutinine for the agglutinable substance of the bacteria; while neither of them is able to bring about agglutination by its own unaided action, yet their presence in solution hinders agglutination by an agglutinine, since they unite with the binding groups of the bacteria, and thus prevent the agglutinine from doing so.

In the same way they suppose that there exist in the bacteria a group that is but little resistant, the agglutinophore, and a second more stable group with which the agglutinine unites, i. e. EHRLICH's haptophore group.

Our own researches have been made with the special object of ascertaining the precise nature of the changes produced both in the agglutinating immune-serum and in the bacteria by the action of various physical and chemical agents upon them; and of clearing up a few of the questions to which the numerous investigations into the nature of bacterial agglutination published during the last few years have given rise.

A. Experimental Methods.

Most of the following experiments were made with growths from a stock culture of *Bacillus coli communis* on the one hand, and with the *agglutinating immune-serum* derived from goats or rabbits after they had been immunised by injections of this race of bacteria on the other; this is the serum and these are the bacteria employed throughout the following experiments wherever no special statement is made to the contrary effect. Additional experiments were made in certain cases with *B. typhosus* and the corresponding typhosus-agglutinating immune-serum.

Following earlier observers we have usually employed *an agar- or bouillon-culture 24 hours old*; the age is specially mentioned where this is not the case. In the great majority of our experiments agar-cultures were employed, for two reasons; firstly, because we wished our experiments to correspond as closely as possible with those of the various writers already mentioned; and, secondly, because emulsions of the bacteria grown upon agar are free from the presence of the numerous unknown chemical substances contained in the bouillon-cultures, and are therefore more likely to give precise and uniform results.

On the one hand, the use of bouillon-cultures is not without its advantages; such cultures are easily prepared, and expose the bacteria to the action of the agglutinine with the least possible disturbance of the natural conditions under which they have been grown.

On the other hand, there are two great objections to the use of bouillon-cultures; one is the presence of many unknown substances in them, as has been already stated; the other is the fact that one has no exact control over the number (or concentration) of the bacteria in such cultures, for different 24-hour growths may show considerable variations in this respect. Finally the very general tendency of bouillon-cultures of *B. coli communis* to spontaneous agglutination must be mentioned, a phenomenon recorded by a large number of experimenters, and one upon which too much stress has often been laid.

The bacteria used in the preparation of the emulsions or suspensions were grown at 37° on the surface of ordinary meat-peptone-agar in large Roux's bottles; the growth was carefully scraped off in as dry a state as possible, and emulsified in 0.85% *NaCl* solution, which will be subsequently referred to as normal saline, very thoroughly. The agar-culture suspension thus obtained was standardised to a definite degree of opalescence or opacity (i. e. $\frac{1}{1}$ *normal emulsion*), by diluting it with normal saline until it presented the same degree of opacity as a certain standard emulsion of arbitrarily chosen strength, to which formaldehyde had been added as a preservative; the comparison and standardisation were effected by the observation of lines ruled on paper through two small test-tubes, filled, one with the standard, and the other with the new emulsion, and held side by side. The employment of some such *standard emulsion* as the starting point for all subsequent experiments is of the greatest importance, and is really an absolute necessity for exact work.

It is well known that the agglutinating power of an immune-serum may vary more than 100%, according as the measurements are made with a denser or a thinner bacterial emulsion (SACQUÉPÉE), and other allied phenomena, such as the combining proportions, the "zones of inhibited agglutination", and so on — exhibit similar wide variations. EISENBERG & VOLK have endeavoured to avoid this source of error by making up the bacteria grown in a given time on a definite area of agar-surface to a definite volume of bacterial emulsion; but the nature of bacterial growth renders such a method of procedure obviously inadequate, and our own experiments have shown us that emulsions of bacteria made up in this manner may vary from one another more than 100% in bacterial concentration. A fresh emulsion in normal saline of a 24-hour agar-culture of our *B. coli* was always acid in reaction; titrated against *NaOH* solution, and using phenol phthalein as indicator, its acidity was equivalent to that of an equal volume of $\frac{1}{10,000}$ to $\frac{1}{20,000}$ normal *HCl* solution.

The agglutinating immune-sera, derived from goats or rabbits, were kept constantly on ice and in darkness; in some cases with the addition of small amounts of chloroform as an antiseptic, in other cases without it. We would here emphasise the fact that we have never been able to observe any irregularities in our experiments that could be attributed to the addition of these small amounts of chloroform to the sera.

The general technique of the experiments was as follows. Small test-tubes, measuring 1.1 cm. $\times$ 7 cm. were set up in series, and into each tube were measured 1.5 c.cm. agar-culture suspension *) or bouillon-culture, together with such an amount

*) Wherever an agar-culture suspension of any given age is mentioned in these pages, a standardised suspension in sterile 0.85% *NaCl* solution of bacteria grown on agar at 37° for the given time is meant. When the age is not mentioned, it is always to be understood that the culture is of 24 hours growth, whether on agar or in bouillon.

of sterile normal saline as would make the total amount of fluid in each tube 2.5 c.cm. after the due addition of the agglutinating fluid — whether serum or acid — had been made. Each series contained 24, 35, or 57 test-tubes in the different experiments; and the amount of agglutinating substance put into each successive tube diminished regularly from one end of the series (tube No. 1) to the other. Each test-tube therefore contained the same quantity of bacterial suspension, and the strength of the emulsion was the same in every tube; but the amount of agglutinating substance added to each was, roughly, $\frac{4}{5}$ of that added to the tube immediately preceding it in the series, and proportionately greater than the amount placed in the tube following next to it. Thus tube No. 1 contained 10 times as much agglutinating substance as tube No. 12, and No. 12 again contained 10 times as much as tube No. 23; in the long series of 57 test-tubes, No. 1 would contain 100,000 times as much agglutinating substance as No. 56. The last tube in every series was kept as a control, containing 1.5 c.cm. emulsion + 1.0 c.cm. of normal saline, and none of the agglutinating substance, thus serving to detect the possible occurrence of spontaneous agglutination. In many of the experiments the normal saline and the agglutinating substance were measured into the tubes first, the 1.5 c.cm. of emulsion being added after them, so as to diminish the experimental error due to the different lengths of time during which the bacteria and agglutinating substance, whether serum or acid, would be acting upon one another in the different tubes. The actual measurements of the amounts of agglutinating substance and normal saline placed in the tubes were made with a 1.0 c.cm. pipette divided into 100 parts, while the emulsion was added from a 10.0 c.cm. pipette divided into 100 parts. The diluted sera and acids were made up with normal saline, except in cases where special mention is made to the contrary effect.

In certain of the experiments, use was made of agglutinating sera that had been exposed for a longer or shorter time to the action of an acid or of an alkali; and here we found that a new source of error crept in. Taking, for example, a series of 24 tubes, the acidified serum added in quantities varying from 1.0 to 0.13 c.cm. to tubes Nos. 1 to 11 would, in the ordinary course of the experiment, be further diluted by the addition of 9 volumes of normal saline to it, before it was added, in quantities varying from 1.0 to 0.1 c.cm., to Nos. 12 to 23. But it was found that a serum which had been acted upon by an acid or an alkali would exhibit a sudden change in its properties on being thus further diluted; so that the continuity that might have been expected to appear in the results was liable to a sudden interruption between tubes 11 and 12, at the point where the further dilution of the acidified serum had been made. This effect was no doubt due to the sudden *change in the degree of dissociation* of some unknown serum-acid compound formed in the acidified serum; it was completely obviated by the employment of a 0.10 c.cm. pipette, divided into 20 parts, for adding the serum to tubes Nos. 12–23,

using, of course the same serum as had already been added (from a 1·0 c.cm. pipette) to tubes Nos. 1—11, without further dilution.

The test-tubes in each experiment were all well shaken up, so as to mix their contents thoroughly, as soon as the appropriate quantities of emulsion, normal saline, and agglutinating solution had been measured into them. They were then placed at once in an OSTWALD'S water-bath at 37° for from 1½ to 2 hours, when they were removed and the measurements of the agglutination that had taken place were made. When it was necessary, owing to slowing of the agglutination and protraction of the time taken by the reaction, the measurements were made a second time after the tubes had stood for a further 18 hours at the temperature of the room.

The actual measurement of the degree of agglutination attained, one of the most important questions in researches such as these, was made by MADSEN'S *method*, which gives admirable results in cases where it can be applied. The method consists, as is well-known, in the arbitrary selection of a single moderately agglutinated tube in one of the series as a standard, and then noting which tube in each of the other series is agglutinated to just the same degree by direct comparison. This can be conveniently done as a rule; but in cases where the size or the character of the flocculi of agglutinated bacteria vary in the different series of tubes, it is impossible to take the measurements by MADSEN'S method.

On such occasions the measurement was set down as standing at the tube containing *the minimum of agglutination visible to the naked eye*; it was necessary to use this method, for example, in many of the experiments upon the influence of heat on the agglutinability of bacteria.

To conclude with a brief estimate of the value of these two methods of measuring agglutinating power, it must be emphasised that in a considerable number of cases *they lead to discordant results*, giving values that differ relatively as well as absolutely; so that given a number of series of tubes, the amounts of agglutinating substance needed to produce the smallest amount of agglutination macroscopically visible will bear no constant relation of the amounts present in the tubes that shew the same degree of agglutination when the measurements are made by MADSEN'S method. In some of the series the two tubes will be close together, in others they will be at some distance from one another; in the former case containing somewhat similar amounts of agglutinating substances, in the latter amounts that are widely different. The explanation of these discrepancies we are unable to give; they appear to depend upon a variety of conditions that will not be further particularised. Which of the two measurements is to be accepted as the correct one is really a matter of opinion; but care must be exercised in accepting as final the results that may be deduced from the application of either of them alone, without reference to the other.

The results of the experiments depend not only upon the method of measurement adopted, but also upon the *length of time that elapses before they are made*. Where the agglutinating power of a series of simple immune-sera is being measured, and unheated agar-culture suspensions or bouillon-cultures are employed, the measurements obtained after the tubes have been kept for 1½ to 2 hours at 37° are practically identical with those taken after they have stood for a further 18 hours at the temperature of the room.

But these two readings lead to totally different results when either the immune-serum or the bacterial suspension or both have been exposed, before mixing, to the action of heat or of an acid or an alkali. Under such circumstances, it is possible for the measurements taken after from 1½ to 2 hours to shew that practically all of the agglutinine in the immune-serum has been destroyed, while 18 hours later it may be evident that almost all of this destruction has been apparent rather than real.

In other words, *the velocity with which the chemical reaction or the physical change upon which bacterial agglutination depends is a very variable factor, and one of the greatest importance for the final result.*

Further researches have also shown us that in many cases *the agglutinating values given by the use of heated bacterial suspensions in no way correspond with those obtained from suspensions that have not been heated*; in just the same way many of the experiments detailed below show that *the values obtained with agar-culture emulsions differ widely from those obtained with bouillon-cultures*. These facts and relations are again of the greatest importance for the proper understanding of the phenomena of agglutination, and have been unduly neglected, speaking generally, by earlier investigators.

Having discussed the methods of measurement, we must lay particular emphasis upon the fact that *under certain various conditions*, when for example either the bacterial suspension or the immune-serum has been exposed to the action of chemical or physical forces, whether of known or of unknown nature, *the degree of agglutination observed may be a quite unreliable index of the amount of agglutinating substance present.*

Passing next to the results of our own experiments, it must first be mentioned that the letters used at the heads of the columns in the different tables given at the end of the paper have the following meanings:

- A. A. the absolute amounts of the agglutinating serum, measured in c.cm., necessary to produce a degree of agglutination equal to that present in the tube selected as standard.
- R. A. the relative amounts of agglutinating serum necessary to produce the given degree of agglutination. The absolute amount of serum which is here taken as unity is given immediately under the letters themselves, in c.cm.

The culture — *B. coli* for example — mentioned at the head of the several columns, is the culture used in that vertical series of experiments; the agglutinating serum used is the corresponding one — a *B. coli* immune-serum in the above case — in every instance.

B. The age of the bacterial culture.

The length of time for which the culture has grown in the incubator at 37° has considerable influence upon the results obtained when it is agglutinated. BOSSAERT was the first to concern himself with the influence of its age upon the agglutinability of the bacterial culture. Our own researches shew that *the age of the culture is of the greatest importance when a bouillon-culture is used, but that it has comparatively little influence upon the agglutinability of agar-culture suspensions*. Thus the figures given in Table I, Series 1 to 5, shew that the suspensions made from agar-cultures of different ages are more or less equally agglutinable (see Series 1, column R. A.), while bouillon-cultures become very considerably less so as they grow older; for example, a 12-day bouillon growth is only one sixteenth as agglutinable as a 24-hour culture (see Series 3, column R. A.), the former requiring 16 times as much serum to produce a given degree of agglutination as the latter. This diminution in agglutinability seems to be mainly if not exclusively due to the development, during the growth of the bacteria in the bouillon, of *certain substances* (the “*toxine*”) which can unite with the agglutinine of the serum and so prevent it from uniting with the agglutinable substance of the bacteria; when large quantities of agglutinine are present, the “*toxine*” can be precipitated. That substances with the above properties are formed in old cultures of *B. coli communis* and *B. typhosus* was first observed by KRAUS in 1897, and they have been described since then by RADZIEWSKY, WASSERMANN, and others.

The proportions in which the bacterial *toxine* and the agglutinine of the immune-serum combine together, on the other hand, have not yet, to the best of our knowledge, been subjected to investigation.

It is quite otherwise with the combinations between bacteria and agglutinines, since these have been the objects of the very extensive and illuminating investigations of EISENBERG & VOLK. These authors have shewn that if increasing quantities of an agglutinine are added to a constant amount of bacterial emulsion, the absolute absorption of agglutinine increases while the coefficient of absorption — that is to say the relation between the quantity of agglutinine that is absorbed and the quantity that was originally present — diminishes. The figures given by EISENBERG & VOLK have been made use of by ARRHENIUS, who finds that the relation

between the agglutinine and the combining-substance of the bacteria can be expressed by the formula —

$$C = KB^{2/3}$$

where C = the quantity of combined agglutinine, K = a constant, B = the quantity of free agglutinine.

Without entering more closely into the quantitative relations of the compounds formed by the agglutinines and their nature, we may state that we have found *that the agglutinine combines with the B. coli "toxine" in quite different proportions.*

Omitting the details of these experiments, we may mention that the B. coli "toxine" employed was the bacterium-free filtrate of a B. coli bouillon-culture kept at 37° for 19 days. In the experiments we made, the amount of this "toxine" was kept constant, the quantity of immune-serum agglutinine exposed to its powers of absorption being varied. It was found that *with increasing amounts of agglutinine, its absolute absorption increased, while the coefficient of absorption* — that is to say, the ratio of the quantity of agglutinine absorbed to the quantity originally present — *remained practically unaltered* within the limits of our experiments. The change in magnitude of the coefficient of absorption was, speaking generally, of such a nature that its value slowly diminished as the quantity of agglutinine exposed to its action grew less. *This result is just the opposite of that found by EISENBERG & VOLK in the case of the bacteria,* so that the formula $\frac{C}{B^{2/3}} = K$ calculated by ARRHENIUS on the basis of their figures does not hold good for the combining ratios of the B. coli "toxine" and the agglutinine. To what extent these facts may modify the present views of the laws that regulate the combinations of agglutinine with the combining substance of the bacteria is being made the subject of further investigation.

C. The effect of heat on the bacterial emulsion.

The diminished agglutinability of bacterial emulsions or suspensions that have been heated has been noted by many experimenters. But the temperature at which this change is first observed and the degree to which it proceeds have been very differently recorded by the various authors, and they are far from unanimous in their explanations of the phenomenon.

VAN DE VELDE, for example found that the agglutinability of his strain of B. typhosus was not diminished when the suspension was heated to 60° for half an hour, but that it fell to $\frac{1}{750}$ of its original value when the suspension was heated to 65° or 70° for a similar period. NICOLLE states that in many cases B. typhosus

becomes inagglutinable after it has been heated to 115° for 20 minutes, while *B. coli communis* loses little of its agglutinability at temperatures below 90° , and does not lose it all even at 140° .

Our own experiments (see Tables II to XI, Series 6 to 52) were conducted partly with agar-cultures of various ages suspended in normal saline, and partly with bouillon-cultures, and were designed to illustrate the change in the agglutinability of *B. coli* produced by heat; experiments were also made with *B. typhosus* for purposes of comparison. The object was to arrive at figures which would express numerically the diminution in agglutinability caused by heating the suspension for a given time to temperatures varying from 40° to 100° , and also to find the diminution in agglutinability consequent on heating the suspension to a given temperature, to 70° or 100° for example, for longer or shorter periods. For all temperatures under 100° the heating was done in a water-bath, which was gradually raised to the required temperature and then left at that temperature as long as was necessary. At 100° the heating was done in a Koch's steam sterilizer. All the experiments of any particular series were carried out at the same time on the same day, so that the values found in each series are directly comparable *inter se*. Every care was taken to prevent any variation in the conditions of the successive experiments from one day to another, or in the details of the heating of the bacterial suspensions or agglutinating sera. It should be noted that *when either a B. coli suspension in normal saline, or a bouillon-culture of it, is heated to 100° for even 15 minutes, it becomes less opaque*. The longer this heating is continued the greater is the loss in opalescence, so that after 6 hours at 100° the suspension is only half as opaque as it was at first. Hence it seems to be best under these circumstances to subject a strong suspension of the bacteria to the heating, and to dilute it to the standard opalescence afterwards, when the effect of prolonged heating upon the bacteria is being examined.

It appears from these experiments that *temperatures below 60° diminish the agglutinability of the cultures but little, while heating them to from 75° to 100° diminishes it very considerably*. In most cases the loss of agglutinability is comparatively small at 70° , the heated suspension requiring only 2 or 3 times as much agglutinine, to produce a given degree of agglutination, as is needed by the unheated culture; but at 80° there is a sudden and considerable loss of agglutinability, which falls to $\frac{1}{10}$ or $\frac{1}{25}$ of its original value. *Hence the agglutinability does not diminish regularly as the temperature rises*; it diminishes further, but not rapidly so, as the temperature increases from 80° to 100° . In spite of all endeavours to obtain uniformity in all the details and in the conditions of the experiments, it is at once obvious that the results of the different series shew very considerable variations, and in spite of the fact that the same agglutinating serum was used in all the experiments of Series 6 to 29. Yet we are unable to explain how it is that a 24-hour agar-culture of our *B. coli* can give such widely varying results, from one day to another, when

its suspensions are exposed to heat and then agglutinated — see Series 6 to 15 — unless it be the case (as was suggested on a previous page) that the discrepancies are more apparent than real, and depend upon the inherent deficiencies of the methods of measuring agglutinating power: at any rate they appear not to depend upon differences in the reaction of the suspensions used. It is to be noted that *the longer an agar-culture has remained at 37°, the less is its agglutinability impaired by the action of heat*, as the figures of Series 22 to 27 clearly shew: and also that the first subcultures taken from a tube of *B. coli* that had been kept at the temperature of the room for six weeks were comparatively little influenced by exposure to heat. But this increased resistance to heat soon disappeared from the successive subcultures made at short intervals from the original tube. If the influence of temperatures between 40° and 100° upon agar-cultures and bouillon-cultures of *B. coli* be more narrowly examined, it will be seen that there is an obvious difference in the behaviour of the two; the bouillon-cultures — see Series 28 and 29 — do not give more uniform results, but illustrate the fact that agglutination can occur in different ways. When an agar-culture suspension has been heated to temperatures between 40° and 100°, it often exhibits *irregular agglutination and a zone where agglutination has been inhibited*, as is shewn by the fact that large amounts of the immune-serum produce a less degree of agglutination than smaller amounts do; this is exhibited in Series 10 to 14, 16 and 17, and 35 and 36. At the same time, one frequently sees that quantities of serum that are insufficient to agglutinate the unheated suspension, will produce agglutination in it when it has been heated; while on the other hand the agglutination produced by a small amount of agglutinine may be equal to, or even greater than, that produced by a quantity 100 times as great, as can be easily seen in the experiments of Series 35 and 36, in which a suspension of *B. coli* was warmed to 70° for various times.

These irregularities do not occur in most instances, or, if they do occur, it is only to a small extent, when heated bouillon-cultures are used; see Series 28 and 29, and 38 to 42. On examining *these irregularities* more closely it is seen that they *do not depend upon the degree to which the agglutinability of the bacteria is lowered*. For such “zones of inhibited agglutination” are often met with in cases where the culture has only been warmed to 60° or 70°, and are absent where it has been heated to 100°; but the opposite may be the case. And again, after the process of agglutination has been proceeding for 2 hours at 37°, great irregularities may be present in the degree to which it has taken place in a series of tubes; but 18 hours later they will often have disappeared, partly or wholly, while the tubes have been standing at the temperature of the room.

Thus there are a number of circumstances tending to prove that when agar-culture suspensions of *B. coli* are warmed, *substances are formed that reduce the velocity of the reaction of agglutination*; but it is doubtful whether such a condition of affairs suffices to explain the whole phenomenon.

Most of the previous workers on this subject agree in giving another explanation of this occurrence; thus LEVIN, working with *B. coli*, supposes that the diminished agglutinability is due to a destruction "— by the heating a great deal of the agglutinable matter in the bacteria is destroyed". EISENBERG & VOLK found that *B. typhosus*, after heating to 100°, almost entirely lost its capacity for being agglutinated, while it preserved almost entirely its power of combining with the agglutinine. They explain this by assuming that the labile agglutinophore group of the bacteria is destroyed, while the stable group that unites the agglutinine to the bacteria is far less easily injured by the action of heat. Thus they draw a close parallel between the facts here and the discoveries made by EHRLICH with reference to diphtheria toxine.

But our researches with B. coli argue entirely against the view that the diminution of agglutinability depends upon a destruction of the agglutinable substance of the bacteria. For if it were here a question of an actual destruction or weakening, comparable to that which has been described in connection with the various bacterial toxines, it is evident that longer continuation of the heating at any given temperature could only result in a further loss of agglutinability, which would finally be complete. This however does not take place; the researches set down in Tables VIII and IX shew that in this matter, as in others, *the results obtained vary according as use is made of a bouillon-culture or an agar-culture suspension.*

If an agar-culture suspension of *B. coli* is warmed to 70° for various lengths of time — for from 1 to 75 minutes — in certain cases (see Table VIII) the agglutinability diminishes more and more the longer the heating is continued — see Series 33. Yet in other instances, such as Series 36, the loss in agglutinability is practically uniform; and in yet others, continued heating even makes the suspension more easily agglutinated than it was originally — see Series 37. But when a bouillon-culture is heated, to say 70°, as in Table IX, Series 38 to 42, the diminution in agglutinability is much the same whether the heating is continued for a long time or for a short.

Again, where an agar-culture suspension of *B. coli* is heated to 100° for periods of from 1 minute to 5 hours — see Table X — it appears that *continued heating gradually restores the agglutinability of the bacteria*, so that in some cases it finally happens that they recover their agglutinability entirely. It is not easy to understand why the same stock of *B. coli* should give such varying results at different times, when no change is made in the immune-serum employed; the experiments in Series 43 to 46 were made with one serum, those in Series 47 to 50 with another.

As regards the effect of the heating of bouillon-cultures to 100° for different lengths of time, the figures in Series 51 shew that the loss of agglutinability remains the same throughout. But if 1% of formaldehyde be added to the culture before it is warmed, then, as the experiments of Series 52 shew, protracted warming causes a partial return of the agglutinability.

As an explanation of this diminished agglutinability, *we believe that some portion of their contents is dissolved out of the bacteria in the process of heating their suspension in normal saline*, and that some substance that unites with the agglutinine is taken up by the fluid in which they float.

We have proved that such a process does take place by filtering off the bacteria from the fresh suspension, both before heating and after it, and have always found that the filtrate from the heated emulsion contained substances capable of uniting with the agglutinine, while no such substance was present in the filtrate from the unheated suspension. And if fresh unheated bacteria are emulsionised in these two filtrates, it will be found that the bacteria suspended in the filtrate from the heated emulsion require considerably more immune-serum for their agglutination than do the bacteria suspended in the filtrate of the unheated emulsion.

The return of agglutinability on prolonged heating at 100° may depend in part upon the slow destruction of these substances that combine with the agglutinine, or upon their conversion into substances that are indifferent to the agglutinine. That some such processes occur is shewn by our experiments with the filtrate from heated *B. coli* emulsions; on further prolonged heating to 100°, this filtrate entirely lost its power of combining with agglutinine. *But these considerations are not enough to account for the very considerable lowering of agglutinability caused by heat*; some other factor which still remains obscure, *possibly a change in the surface-tension of the bacterial envelope*, must be at work as well.

It might be urged, in opposition to the foregoing views as to the agglutination of bacteria heated for long periods, that it is wholly different in character from that of bacteria that have been heated for only a short time, or that have not been heated at all, and is therefore, perhaps, not a specific reaction at all. But the evidence for the specific nature of the agglutination produced by the serum is as good in the one case as it is in the other; and, further, very similar phenomena have been noted by DREYER in the case of a *megatheriolysine*.

This lysine, on being warmed to 60° for half an hour, was found to lose its power of haemolysing red blood-corpuscles; but if the same lysine-solution were then warmed to 100° for 10 minutes, it recovered a portion — perhaps a quarter — of its original haemolytic power. If the lysine be heated directly up to 100°, its power is reduced to $\frac{1}{6}$ of what it was originally; while if it be kept at 100° for 10 minutes, its activity partially returns, and it may be found to have half of its original power of haemolysing red cells. Here again, it might be argued that the megatheriolysine thus reactivated by heat is not identical with that originally present; but no such difference really exists between the two, because the *specific anti-megatheriolysine is able to prevent haemolysis by the megatheriolysine heated to 100°, just as it does haemolysis by the unheated megatheriolysine*.

D. The effect of heat on the agglutinating serum.

This question has been attacked by a number of investigators. Thus JATTA found that a serum agglutinating *B. typhosus* lost none of its power after being kept for 3 hours at 55°. Most authors — BAIL, EISENBERG & VOLK, and others — have found that *B. coli* and *B. typhosus* immune-sera lose a little of their agglutinating power after being kept for half an hour at 65°, most of it at 70°, and all of it at 75°. The use of sera heated in this way often results in the appearance of "zones of inhibited agglutination", when they are added in regularly diminishing quantities to a long series of test-tubes. In other words, comparatively large amounts of the agglutinating serum fail to produce agglutination, while small quantities of it do agglutinate the bacterial emulsion.

The descriptions of this phenomenon known to us are qualitative, and do not give exact numerical details of the circumstances under which it occurs, nor do they state whether the immune-serum was heated by itself, or in a condition of dilution.

Our own experiments, detailed in Tables XII to XVIII, Series 53 to 68, were made with three separate *B. coli*-agglutinating immune-sera derived from a goat. The serum in some cases was heated by itself, in others after dilution with normal saline.

And here again it must be emphasised that *the results obtained differ according as the measurements are made with a suspension of the bacteria grown on agar, or with a bouillon-culture*. The absolute as well as the relative agglutinating values are quite different in the two cases. Further, *the results obtained depend very largely upon the time at which the measurements of the agglutination that has taken place are made, because the velocity of the reaction is often much diminished*.

In consequence of this, we have generally tabulated the results of measurements that were taken after various periods of time had elapsed in the several experiments; similarly, the agglutinating powers of the sera were tested on both agar-culture suspensions and bouillon-cultures of the bacteria. In all cases where the experiments were thus duplicated, care was taken to perform the two sets simultaneously, and to make use of the same specimen of the diluted serum, whether heated or not. Thus these experiments are parallel and strictly comparable to one another in every possibly way.

In agreement with previous workers, we have found that *temperatures not above 60° do not diminish the agglutinating powers of B. coli immune-sera*; no "zones of inhibited agglutination" and no other irregularities were observed in the agglutination obtained — see Tables XII and XIII.

The results were the same whether the serum were heated by itself alone or in a state of dilution.

When the serum was heated to 65° , differences appeared according as it was heated after dilution with normal saline or by itself alone; and when such heated sera were used to agglutinate an agar-culture suspension, "inhibition-zones" appeared. For example, the experiments in Series 54 shew that an agglutinating serum heated alone to 65° for $\frac{1}{2}$ hour, when present in from 2500 to 29 times the unit quantity of the unheated serum needed to produce the definite degree of agglutination present in the test-tube selected as standard, may cause either no agglutination at all, or else a less degree of agglutination than that present in the standard tube; while the agglutination in the tubes containing from 28 to 2 of the agglutinating units is either total or more marked than it is in the standard tube.

But if the serum is diluted with 9 volumes of normal saline before being heated, the results obtained are quite different. The tubes containing from 250 to 125 agglutinating units of serum may shew no agglutination, while the tubes containing from 125 to 2 agglutinating units may be more strongly agglutinated than is the standard tube containing the single agglutinating unit of the unheated serum. So in the second of these two cases the "zone of inhibited agglutination" is less extensive than it is in the first; in one case it ends at the tube containing 125, in the other, at the tube containing 29 agglutinating units of the heated serum. Examination of the other figures obtained with sera heated to 65° or 70° will be found to shew very similar results.

Thus, *the more concentrated the solution in which the immune-serum is heated, the more readily do "zones of inhibited agglutination" appear.* Also, inspection of the measurements recorded after the lapse of various periods of time will shew that the longer the time that passes before the measurements are made, the less extensive will the "zone of inhibited agglutination" be found to be; see Series 63 and 65. In fact, a "zone" may entirely disappear if the tubes are examined a second time after they have stood for a further 18 hours at the temperature of the room, as was the case in the experiments of Series 59 and 61.

If the agar-culture suspension of *B. coli* used for the measurements be now replaced by a bouillon-culture, it is probable that no "zone of inhibited agglutination" will be found to occur, as may be observed in the figures in Series 58, 60, 62 and 64; or if it does occur, as in Series 66 and 68, it will only be feebly marked. The employment of sera that have been heated may also lead to *the appearance of other curious phenomena* in addition to the "zones of inhibited agglutination". Thus if an agglutinating serum diluted with nine volumes of normal saline be warmed to 70° for periods of 30 minutes, 1 hour, and 2 hours (see Series 65) and if the agglutinating powers of these three diluted specimens be then measured on an agar-culture suspension, it will be found that they have not diminished, but have, on the contrary, actually increased, so that their agglutinating powers are now $\frac{2}{1}$, $\frac{2}{1}$ and $\frac{5}{4}$, respectively, of that of the unheated serum in the same state of dilution. But if these same heated sera be tested with a bouillon-culture (see Series 66), their strengths

are found to be only $\frac{1}{2}$, $\frac{1}{2}$ and $\frac{1}{3}$, respectively, of that of the unheated serum. Yet in spite of this, "zones of inhibited agglutination" are a far more prominent feature with the agar-culture suspensions than they are with the bouillon-cultures of *B. coli*.

Continuing with these experiments, it is seen that *prolonged heating to 70° causes this increased agglutinating power, seen only when agar-culture suspensions are used, to disappear again*. Thus the serum diluted 1:10 became twice as strongly agglutinating after being heated at 70° for half-an-hour; but after 2 hours at 70° it was only a little stronger than it was before being heated; it must be emphasised that these measurements were made on the agar-culture suspension of *B. coli*. The experimental results detailed in Series 59 to 68 shew that within certain limits *the greater the dilution at which the heating is performed, the greater is the reduction of the serum's agglutinating power*, whether bouillon-culture or agar-culture suspension be employed — though the fact is best illustrated when the former is used. To quote an example, if the agglutinating immune-serum in the three dilutions 1 in 10, 1 in 100, and 1 in 1000 be heated to 70° for 1 hour, and the agglutinating powers of the three dilutions be then measured on a 24-hour bouillon-culture of *B. coli*, they will be found to have fallen to $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ of their original values — see Series 68. If, on the other hand, an agar-culture suspension be employed, the results, as is shewn by the figures in Series 67, are quite different. The agglutinating power of the 1 in 10 dilution is twice what it was before, while the 1 in 100 dilution is a little weaker (in the proportion 1 to 1·3), and the 1 in 1000 dilution has only one half of the agglutinating power it had before the heating.

It results from all these sets of experiments that *the weakening of the agglutinating power of the B. coli serum is much more apparent when the measurements are made using bouillon-culture, than when an agar-culture suspension is employed*.

At the present moment it is impossible to say which of the two sets of results mentioned above should be regarded as giving the more correct view of the effect of heat upon agglutinating immune-sera. Further observations with other varieties of serum are needed before that question can be decided; and such experiments as are now in progress have not advanced sufficiently far to permit definite conclusions to be drawn.

The figures quoted in Series 67 and 68 further shew that if the dilutions of the agglutinating immune-serum be made with 1% normal horse-serum instead of with normal saline, the loss of agglutinating power on heating to 70° will be greater. This fact is particularly striking when bouillon-culture is used in making the measurements, when, also, a "zone of inhibition" occurs which is, however, small in extent, and diminishes if the test-tubes are allowed to stand and are observed again after the lapse of many hours.

The occurrence of these "zones of inhibited agglutination" is explained by EISENBERG & VOLK as due to the conversion of a part of the agglutinine into agglutinoid

by the action of heat. The agglutinoid cannot produce agglutination, but it has a stronger affinity for the agglutinable substance of the bacteria than is possessed by the agglutinine, whose action it is, in consequence, able to prevent. In confirmation of this view they bring forward the statement that the greater the destruction of the agglutinine, the more pronounced is the "inhibition zone". But this explanation is inapplicable to the results of *our experiments, which prove clearly that the actual destruction of the agglutinine does not depend upon or stand in any definite relation to the extent of the "zones of inhibited agglutination"*. The agglutinating power of a serum can be much weakened while the "inhibition-zone" is but ill-marked; and conversely, an extensive inhibition-zone can occur when the destruction of agglutinine has been *nil*, or when its power has actually been increased by the heating.

If the question were one of the formation of an agglutinoid at the expense of the agglutinine, then "zones of inhibited agglutination" of equal extent should appear whether bouillon-culture or agar-culture suspensions are agglutinated; but this has been found not to be the case. And a final objection to this view of the origin of the "zones" lies in the fact that they may also appear when it is the bacterial culture that is exposed to heat, and not the agglutinine, and when the quantity of the substance formed by the heat is the same in every test-tube of the series — for each tube contains the same amount (1.5 c.cm.) of the bacterial suspension or culture.

We are of the opinion that the phenomenon can be partly explained by the considerable retardation of the velocity of the reaction producing agglutination. In the process of heating the immune-sera or the bacterial emulsion, compounds are formed which can impede agglutination of an agar-culture suspension when they are present in large amount, and accelerate it when present in small amount; in the latter case the action may perhaps be catalytic in nature.

The slowing of the velocity with which the agglutination proceeds is best seen when agar-culture suspensions are used. For example, in Series 61, a serum diluted with 9 volumes of normal saline was warmed to 70° for half an hour. Measurement of the agglutination it had produced in an agar-culture suspension after standing for 1¼ hrs. at 37°, indicated that the serum's agglutinating power had fallen to $\frac{1}{71}$ of its original value; after 2½ hrs. at 37°, it appeared to have fallen to $\frac{1}{7}$ of its original value; about 18 hours later, its loss of agglutinating power was shewn to have been quite small. In Series 62 the same heated serum was used to agglutinate a bouillon-culture of *B. coli*; and the measurements, taken after the lapse of identical periods of time, indicated losses in agglutinating power represented by the figures $\frac{1}{2.4}$, $\frac{1}{1.4}$ and $\frac{1}{1.2}$ respectively.

So the conclusion may be drawn that *the velocity of the process of agglutination is retarded far less with bouillon-cultures than with agar culture suspensions*; and

this fact corresponds with the observation so frequently made, that "zones of inhibited agglutination" are seen to occur far more frequently in the latter than in the former.

E. The action of acids upon the bacterial suspensions.

MALVOZ was the first to draw attention to the fact that acids and certain other chemical substances are able to produce the agglutination of bacteria. This agglutination by acids cannot be distinguished from that produced by an immune-serum, either macroscopically or by the use of the microscope. Hence there seems to be no just reason for believing that they are due to two different causes, as NICOLLE and DEFALLE are inclined to do.

Neither MALVOZ nor the investigators who have followed him, LAMBOTTE & BOSSAERT, SABRAZÈS & BRENGUES, DEFALLE, NEISSER & FRIEDEMANN, CRAW, and others, have given any exact description of the curious course taken by this acid agglutination. Our own experiments have been made with *B. coli* for the most part, which is referred to in all cases where no special notice to the contrary effect is given; a number of experiments were also made with cultures of *B. typhosus*.

The results of the experiments once more illustrate the rule that *the results obtained with agar-culture suspensions and bouillon-cultures do not agree*. The normal saline suspension of *B. coli* is very easily agglutinated by *HCl*, while the bouillon-culture is but difficultly so; but an emulsion in bouillon of the bacteria grown upon agar is, again, comparatively readily agglutinated by the acid.

The most striking characteristic of agglutination by an acid is the irregularity with which it proceeds, as is seen when the acid is added in steadily diminishing quantities to a long series of the test-tubes.

Strong or complete agglutination is produced by both large and very small amounts of acid, while the intermediate quantities that lie between these two extremes produce little agglutination or even none at all; this is clearly illustrated by the figures given in Table XIX. This table also exhibits the remarkable variability of the successive subcultures derived from a single stock of *B. coli* and grown on a single cultivating medium; the variable agglutinability shewing itself mainly in the agglutination produced by the very small amounts of acid.

Very important here is the degree of opacity of the bacterial emulsion employed, much more so than it is in the agglutination produced by an immune-serum. This is shewn by the fact that the "zone of inhibited agglutination" occupying the tubes

intermediate between those containing the large and the very small amounts of acid, when a normal emulsion is used, *becomes smaller and smaller and finally disappears as stronger and stronger emulsions are employed* — that is to say, emulsions containing more and more bacteria in a given volume; while at the same time the lower limit of agglutination progressively rises, as is shewn by the figures in Table XX, Series 75, where the experiments were made with orthophosphoric acid.

The agglutination of *B. coli* by acids and the manner in which it occurs resemble in many ways the "sedimentation" produced by the interaction of various substances and studied by NEISSER & FRIEDEMANN. Thus, when a $\frac{1}{2}$ -normal solution of ferric chloride is added to an aqueous suspension of gum mastic, the latter is precipitated; using varying quantities of the ferric chloride solution, they found that intermediate zones might occur in which this sedimentation did not take place, and that these zones were progressively curtailed as stronger and stronger gum mastic suspensions were employed. This observation exactly agrees with what we have found to be the case in the agglutination of bacteria by acids, which shews that the phenomenon is not peculiar to the last-mentioned class of suspensions, and is of more general occurrence. The experiments of NEISSER & FRIEDEMANN and of BECKOLD that are here referred to, contain many more points of interest that will not be further discussed in this paper; it is to be hoped that further researches that are now under way will clear up a number of the questions that suggest themselves for solution.

If an agar-culture of B. coli be heated to from 50° to 100°, it loses much of its power to be agglutinated by an acid; see Tables XXI and XXII, in which the results of the same experiment are tabulated in two different ways for the sake of clearness. The figures given in Table XXII record the fact that the agglutination of a suspension heated to 80° may demand 19 times as much orthophosphoric acid as is needed by the same emulsion when unheated, while that of a suspension kept at 100° for an hour may require 1000 times as much acid as it does before the suspension has been heated at all. It is to be noticed that the first sudden diminution in agglutinability by an acid that is caused by heating occurs between the temperatures of 70° and 80°, just as has been shewn to be the case with the agglutination produced by an immune-serum. This circumstance, too, speaks in just the same way against the view that the effect of heating the suspensions is to destroy certain specific substances in the bacteria, corresponding to the immune-bodies in the agglutinating serum; but it affords support to the view held by us, namely that a change takes place in the physical conditions under which the agglutination proceeds, and that the clumping together of the bacteria is impeded.

Finding that different acids exhibited the power of agglutinating an emulsion of *B. coli* in very different degrees, we performed experiments with the object of ascertaining whether there was any connection between what is commonly known as the "strength" of an acid (as measured by its power of inverting cane-sugar) and

its power of agglutinating bacteria. The figures given in Series 77, Table XXIII, make it quite plain that *it is impossible to find any connection between the sugar-inverting power of various acids and their power to agglutinate B. coli*. It can here be seen, for example, that while hydrochloric acid has 21 times the sugar-inverting power of monochloroacetic acid, it only possesses $\frac{1}{7}$ of its power to agglutinate *B. coli*. There is one point serving to differentiate agglutination by an acid from that due to an immune-serum that may be mentioned here, which is that bacterial suspensions that have been freed from excess of salts by dialysis can be agglutinated directly by an acid, while an immune-serum can only produce agglutination when a salt has been added to the mixture. Thus agglutination by an acid does not demand that a salt should be present in quantities that can be readily detected by chemical means.

Before leaving the subject of agglutination by acids, it may be worth while to record briefly the action exerted upon its course by the addition of the normal serum of a horse; for this illustrates the conditions obtaining when an immune-serum is used for agglutination after it has been treated with an acid, and may help in the elucidation of the phenomena there observed. Table XXIV records the results of a single experiment; an emulsion of a 24-hour agar-culture of *B. coli* was divided into 4 parts, to 3 of which normal horse-serum was added in the proportion of 10, 1 and $\frac{1}{10}$ parts per mille; acting by itself, this horse-serum was very feebly agglutinative, 0.2 c.cm. being required to produce the minimum visible agglutination in 1.5 c.cm. *B. coli* suspension, a quantity corresponding to 8.0 per cent of the 2.5 c.cm. present (as previously explained) in each test-tube. This horse-serum was not added to the emulsion used in column A, which therefore served as the control series. The experiment was then made of producing acid-agglutination in the 4 sets of tubes, using *HCl* as agglutinant in the same amounts as in the experiments already described. It was found that quantities of *HCl* varying between 3.65 and 0.73 milligrams per tube produced a feebler degree of agglutination in the control-series A than was present in the tube selected as standard (denoted S), while in the columns B and C no agglutination at all was produced by from 3.65 to 0.4745 mgrm. *HCl*. In column D on the other hand, a weak degree of agglutination was produced by from 3.65 to 2.19 milligrams of *HCl*, while no trace of agglutination at all was produced by from 1.825 to 0.4745 milligrams of the acid. It is further seen that the smallest amounts of acid producing agglutination in the 4 sets of tubes were 0.04745 mgrm. in the two sets A and D, and 0.06205 mgrm. in C, and 0.09125 mgrm. in B.

In other words, this experiment shews that when present in quantities of from 1.0 to 0.01 per cent, *normal horse-serum can lessen or prevent the agglutinating powers of both large and small quantities of acid*, that are able to produce agglutination in the control-series of test-tubes, *but that it may be without influence upon the intermediate amounts of the acid*.

At the same time the agglutination observed in set D shews that the 0.01 per cent of horse-serum may have no recognisable influence upon the agglutinating action of the large or the small amounts of acid, but may yet impede the action of the intermediate quantities, thus increasing the extent of the already more or less well-marked "zone of inhibited agglutination" that so commonly occurs in the tubes that contain the intermediate amounts of acid.

The fact that the inhibiting influence of normal horse-serum upon the agglutination caused by the acid does not follow the laws of simple proportion is evident from the results given in columns B, C, and D; for while the addition of 0.1 per cent of the serum diminishes the action of a given quantity of acid to about $\frac{2}{3}$ of its usual value, the addition of 1.0 per cent of the serum diminishes it to only one half.

Proceeding now to give a short account of the agglutination by immune-serum of *B. coli* emulsion acidified by the addition of various quantities of acid, we have found, as experiments already detailed would lead one to expect, that *the agglutinability exhibited by such acidified emulsions is extremely sensitive to minute variations in the amount of acid they contain*. Thus it appeared that the addition of *HCl* in the proportion of 0.03 milligrams to each test-tube containing 1.5 c.cm. $\frac{1}{1}$ normal emulsion — a quantity of acid that would produce a just visible agglutination if acting by itself alone — did not recognisably affect the agglutination caused by the immune-serum; 0.06 mgrm. of the acid, which by itself would cause strong agglutination, may diminish the agglutinability of the suspension by serum to $\frac{1}{15}$ of the value it gives when not acidified; while both 0.24 and 0.48 mgrms. of acid, each of them quantities that would produce agglutination if acting alone, depressed the agglutinability to $\frac{1}{33}$. Hence acidification of the emulsion makes it much less easily agglutinated by the immune-serum. At the same time it makes the whole course of the agglutination liable to irregularities; and *causes the occurrence of "zones of inhibition", and of paradoxical agglutination*, in which a single tube at some point in a set may exhibit marked agglutination, while its immediate neighbours on either side show none. It is important to note that if the *B. coli* emulsion in which the acidification has prevented the occurrence of agglutination be suitably neutralised with *NaOH* solution, then agglutination ensues in a normal manner; this shews that there can be no question here of a destruction of the agglutinable group in the bacteria by the acid, similar to that which EISENBERG & VOLK have assumed to take place in the case of *B. typhosus*.

So that the presence of these small quantities of *HCl* — quantities of 0.03 to 0.48 mgrms. of the acid in the 2.5 c.cm. of immune-serum, normal saline, and bacterial suspension made up as already described — that would cause agglutination if acting alone, suffices to inhibit the agglutinating action of from 2 to 33 times the amount of immune-serum that produces agglutination when acting by itself. And no agglutination at all may be produced in tubes that contain enough

immune-serum and enough acid to produce total agglutination by either of these substances if they were acting upon the emulsion separately instead of together.

Very similar conclusions were reached with our stock-culture of B. typhosus.

The figures obtained in the researches detailed in the preceding paragraphs varied widely from one day to another, and were even contradictory. Hence it was not possible to arrive at definite numbers that would satisfactorily express the precise relations that exist here. For this reason we have contented ourselves with the qualitative statements given above.

F. The action of acids upon the agglutinating immune-serum.

The action of acid upon an agglutinating immune-serum has been subjected to searching investigations at the hands of PICK, EISENBERG & VOLK, and others. They have found that an acid can inhibit the specific action of the serum when it is present in sufficiently large quantities, but not if its quantity is small. These facts cannot be doubted, and the change produced in the immune-serum by the acid is probably similar in nature to that produced by the action of heat upon it.

EISENBERG & VOLK, who are followed by later experimenters, explain the phenomena by saying that a portion of the agglutinine is converted into agglutinoïd. But they did not take the precaution in their experiments, so far as one is able to see, of measuring the quantity of free acid present in the various test-tubes from which they drew their experimental results; nor do they state to what extent their bacterial stock could be agglutinated by hydrochloric acid acting alone. Hence it is possible that a portion of the agglutination they describe in the Tables of their results is due to a combination of acid and immune-serum agglutination, or even to acid-agglutination alone.

Our own researches were made in the following manner. Hydrochloric acid, in various quantities and in exactly-measured degrees of dilution, was allowed to act upon the coli immune-serum, either before or after its dilution, for about 2 hours at 37°. The acidified serum was then used for experiment, in some cases directly, in others after careful neutralisation with sodium hydrate solution. Its agglutinating power was measured on both agar-culture suspensions and bouillon-cultures of the bacteria; as the results given later shew, it is very important that cultures of both kinds should be employed. We examined the effects of both small and large quantities of the acid, allowing it to act upon the serum in strengths varying between $\frac{1}{7000}$ and about $\frac{3}{4}$ normal *HCl*; some of the results

obtained are set down in Tables XXV to XXXII, Series 79 to 90. The figures in Series 81, Table XXVI, where the agglutinating power of the serum treated by acid was measured upon an agar-culture suspension of *B. coli*, give evidence of the fact that extremely minute quantities of *HCl*—from 0·0005 to 0·0007 per cent—do not recognisably alter the agglutinating power of the immune-serum; while amounts varying from 0·001 to 0·01 per cent of acid usually make the serum more actively agglutinative than it was before the addition of the acid was made—but in these particular experiments it not infrequently happens that irregularities and “zones of inhibition” occur to interrupt the steady course of the agglutination. Yet such irregularities are not due directly to the amount of the acid which has been added, for they do not occur in the sets of tubes containing from 0·0005 to 0·0007 or from 0·0025 to 0·015 per cent of acid; but they are often seen in the sets of tubes containing intermediate amounts of acid, namely from 0·001 to 0·002 per cent. To give a single instance of the intensifying influence of these small amounts of acid, the figures in Series 81 prove that the presence of 0·00013 mgrm. of *HCl* in the immune-serum added to a tube can increase its agglutinating power fourfold.

The addition of somewhat larger amounts of *HCl* alters the agglutinating power of the serum in a different way. A *B. coli*-agglutinating serum, diluted 1 to 100, and acidified with *HCl* to 2·439 per mille (i. e. to about $\frac{1}{15}$ normal *HCl*) as in Series 81, produces no agglutination in 1·5 c.cm. agar suspension (diluted to 2·5 c.cm.) when added in amounts of from 0·01 to 0·00085 c.cm., although these quantities contain from 25 to 2·13 agglutinating units; but at the same time, from 0·00085 to 0·00012 c.cm. of this acidified serum will produce nearly total agglutination, though 0·00012 c.cm. represents only $\frac{1}{3}$ of an agglutinating unit.

Thus it is clear that *when the agglutinating power of the immune-serum thus treated with acid is measured on an agar-culture suspension of B. coli, there are two limiting values to choose from, a higher one that proves the serum to be weaker than, and a lower one that proves it to be about three times as strong as, it was before it was treated with the acid.* The question now arises—*which of these two values, if either, correctly represents the process that is being measured?*

If the quantity of acid present in the different test-tubes that are agglutinated to the same degree as the tube chosen as standard be calculated, it is found that they all contain more or less the same amount of acid, whether the agglutinating power appear to be diminished or increased, and although the various sera used have been treated with widely differing quantities of acid and are present in widely varying amounts. The numbers given in Series 81, for example, shew that in the several sets of test-tubes in which the differently acidified sera—which contain from 0·408 to 2·493 parts per mille of *HCl*—have been added, the lower limit of agglutination to the standard degree always occurs at the tubes containing from 0·029 to 0·026 mgrm. *HCl*, while the amount of the agglutinating serum in these tubes varies between 0·00012 and 0·0007 c.cm.

These facts cannot be properly appreciated until the ability of the *HCl* to produce agglutination when it is acting alone has been measured.

Series 81 shews that in this particular agar-suspension, agglutination as strong as or even stronger than that in the standard tube was produced by quantities of from 0.146 to 0.026 mgrm. of *HCl*.

Hence the apparent increase in the agglutinating power of the serum depends upon the presence of these small amounts of acid (from 0.029 to 0.026 mgrm.) which are capable of producing the agglutination by themselves alone; and the experiments just recorded prove that the agglutinating action of these small quantities of acid is not prevented by the particular amounts of immune-serum that are being considered here. So much then for the lower limit of the "zone".

For the position of its upper limit, at which it comes to an end, very similar considerations hold good. The tubes that are agglutinated to the same extent in the different series are found to contain nearly the same (or the calculated) amount of acid, quite independently of the amount of acid with which the sera were treated, or of the quantity of serum present in these tubes. The experiments in Series 81, 84, and 88 bring this out clearly. One cannot help a feeling of surprise that the quantities observed should tally so closely with those calculated, for the upper limit of the zone as well as for the lower.

It will also be noticed that when the measurements are made in an agar-culture suspension, the extent of the inhibition zone produced by the acidified serum does not, within wide limits, vary with the amount of acid with which the serum was treated, but depends solely upon the amount of acid present in the quantity of acidified serum placed in the given tubes; this can be seen by reference to Series 82.

The figures given in Table XXXII, Series 90, illustrate the fact that a precisely similar explanation may be given of the "zone of inhibition" observed when an emulsion of *B. typhosus*, derived from our stock culture, is exposed to the action of acidified *B. typhosus* immune-serum.

Thus we are unable to accept the explanation of the phenomena here described that has been given by other experimenters.

Our own view of the diminished agglutinating power and of the "zones of inhibited agglutination" met with in the acidified sera is that both are mainly if not entirely due to diminution in the velocity of the reaction; this diminution being caused by the presence, in certain proportions, of the acid. The apparent increase in the agglutinating power of the serum is due solely to the power possessed by the acid of agglutinating per se when it is present in sufficient quantity.

Inspection of the figures set down in Tables XXX and XXXI, Series 88 and 89, brings out the fact that there are striking differences between the two readings obtained, the one immediately after the tubes have been in the waterbath at 37° for 1½ hours, the other after they have stood for a further 18 hours at the temperature of the room. The extent of the "inhibition-zone" is much diminished in

the latter case, and also the apparent loss in agglutinating power experienced by the serum is much less. It is evident, too, that the important factor here is not the strength of the acid to which the immune-serum was exposed; but that it is the amount of acid (in the form of acidified serum) added to the tubes at the "zones" upper and lower limits.

The experimental results detailed in Series 88 and 89 shew that although the agglutinating serum employed in one set of tubes may be treated with 10 or 15 times as much acid as in the serum used in another set, yet the "zone of inhibited agglutination" will come to an end, in either case, at that tube in which the amount of acid added in the form of acidified serum is less than about 0.2 mgrm.; yet in the one case the amount of agglutinating serum present in this tube is some 22 times as great as it is in the other.

Hence there can be no question here of the conversion of agglutinine into agglutinoïd, as EISENBERG & VOLK, and others have supposed to be the case. The experiments just detailed prove this, and further proof is given by the fact that by suitable neutralisation of the acidified serum, both the zone of inhibited agglutination and the apparent increase or reduction in the agglutinative power of the serum disappear, completely or nearly so, this depending upon the amount of acid with which the immune-serum was originally treated.

Since the results obtained here by ourselves stand in absolute contradiction to those found by EISENBERG & VOLK, it is necessary to look more closely into the significance of this neutralisation of the acidified serum and certain other points.

The method of experiment was as follows. The immune-serum was exposed to the action of the acid for 2 hours at 37°, in a water-bath. The subsequent neutralisation of a portion of it is, however, a matter of no little difficulty; for some compound is formed between the acid and the serum that is but slowly decomposed by the alkali (*NaOH* solution) towards the end of the neutralisation, or even when the alkali is present in slight excess. The effect of this is that when almost the whole of the calculated quantity of *NaOH* solution has been added to the acidified serum that is to be neutralised, the mixture shews a markedly alkaline reaction with phenol-phthalein; but less than half an hour later it will be acid again, and this alternation can be repeated several times in succession by the slow addition of the alkaline solution. Hence it is impossible to neutralise an acidified serum with any great degree of chemical precision. A further difficulty arises from the fact that a serum unites equally readily with either an acid or an alkali (*HCl* or *NaOH*). As the destructive effect of an alkali upon the agglutinine is much stronger than that of an acid, a new factor appears which must not be overlooked when an estimate of the destructive effect of an acid upon an agglutinating immune-serum is being estimated by the results of neutralisation experiments such as those described above: and it must be mentioned finally that when even very small

amounts of acid are present, fluctuations in their value exert a very powerful influence upon the agglutination produced by an immune-serum.

Tables XXVII to XXXI record the results obtained when the serum is first treated with an acid and then neutralised. They shew that, speaking generally, the "zones of inhibition" and the increased agglutinating power both disappear on neutralisation. With reference to the diminution that sometimes occurs in the agglutinating power, it is to be observed that when comparatively small amounts of the acid have been employed, the return of agglutinating power to the serum on neutralisation is almost complete; but that if larger and larger quantities of the acid are allowed to act upon the serum and the mixture is then neutralised, the reduction of the agglutinating power does grow progressively greater and greater. Still, a part, at least, of the agglutinating power always returns (within wide limits, that is to say), where neutralisation is performed.

In the same way the velocity with which the agglutination takes place is very considerably diminished when the immune-serum has been treated, before neutralisation, with tolerably large quantities of *HCl* — with $\frac{3}{4}$ normal *HCl*, for example. The figures set down in Series 88 and 89, where the serum was treated with 2.283 per cent *HCl*, shew that after the neutralised serum had acted for $1\frac{1}{2}$ hour at 37° upon the bacterial emulsion, its agglutinating power appeared to be only $\frac{1}{17}$ and $\frac{1}{7}$, in the two cases respectively, of that of the untreated serum. The same test-tubes, examined 18 hours later, shewed that their powers were by that time only reduced to $\frac{1}{5}$ and $\frac{1}{2}$ of what they had been before they were acidified.

All of the observations quoted above were made upon agar-culture suspensions of *B. coli*.

The results obtained from bouillon-cultures are both qualitatively and quantitatively different. This is shewn to be the case by the results of experiments made simultaneously upon the same day and with identical dilutions of the immune-serum, so that they are as strictly comparable one with another as is possible.

It is made evident in Tables XXV, XXVIII, and XXIX, Series 79, 80, and 84 to 87, *that with bouillon-cultures, the "zones of inhibited agglutination" are a less prominent feature.* They do not occur unless the serum has been treated with very considerable quantities of acid — quantities that are perhaps 20 or 30 times as great as those required to produce "zones" when the agar-culture suspension is employed. None the less, however, the agglutinating power of the immune-serum may be reduced to $\frac{1}{19}$ of its original value under such conditions as these — see Table XXV, Series 80.

But if the acidified serum is neutralised before use with the bouillon-cultures, it becomes apparent that in this case also the loss of its agglutinating power is to some extent apparent rather than real; for with neutralisation, the serum recovers its agglutinating power to a large extent or even entirely.

Still, Tables XXVIII and XXIX shew that *the actual destruction of the acidified immune-serum's agglutinating power is greater if bouillon-culture is employed for the measurements than when an agar-culture suspension is used.*

If a bouillon-culture is made use of, one does not observe an increase in the serum's agglutinating power, as may be the case when a suspension is made the subject of the experiment. As has already been pointed out, this is because a bouillon-culture is not readily agglutinated by an acid, so that the minute quantities of acid that have come into play are unable to produce an apparent increase in the serum's capacity for producing agglutination.

The experiments suffice to shew that *also in the case of bouillon-cultures, the extent of the "zones of inhibition" observed does not depend upon the actual destruction of the agglutinine that has taken place*, the limits of the "zone" are determined by the presence of just such an amount of acid in the tubes where it occurs as will prevent the bacteria from coming together, and bear no relation to the strength of the acid to which the serum was exposed.

In conclusion we shall give a brief account of the experiments we have made that illustrate:

G. The action of alkalies upon the process of agglutination.

We have never been able to find that solutions of caustic soda (NaOH) have any agglutinating influence upon our stocks of *B. coli* or *B. typhosus*, whether added in large quantities or in small. Like other experimenters however, we have observed that even when added to the bacterial emulsion in relatively small quantities, the alkali renders it more translucent. It appears that *B. coli suspensions, to which regularly increasing amounts of caustic soda have been added just as acid was added in experiments already described, lose much of their power of being agglutinated by immune-serum*: the agglutinability grows progressively less as increasing quantities of the alkali are added. But such experiments as we have made in this direction have failed to bring to our observation any such irregularities in the agglutination, or any of the "zones of inhibited agglutination" that are of such frequent occurrence when acid is here made use of. With the alkali, diminishing amounts of the immune-serum always produce diminishing degrees of agglutination.

Acting upon the agglutinine of B. coli immune-serum, caustic soda is far more destructive than is an equimolecular solution of hydrochloric acid. For example, HCl

of $\frac{1}{120}$ normal strength destroys practically none of the agglutinine; while the equimolecular NaOH solution, acting under identical circumstances, may reduce the agglutinating power of the immune-serum to $\frac{1}{30}$ of its original value.

Still, in the case of the alkali as with the acid, *the apparent destruction of the agglutinating power is greater than the actual destruction*, as is shewn when the alkalisied serum is neutralised with the calculated quantity of HCl , and two series of tubes are set up, one for the alkalisied serum and the other for the same serum after it has been thus neutralised by the addition of HCl .

But although the actual destruction of agglutinine is greater in the case of the alkali than it is with the acid, there is *much less tendency to the appearance of "zones of inhibited agglutination"* and the other irregularities already detailed, in the former case than there is in the latter.

And here again we would advance the view that *the phenomena are largely due to a diminution of the velocity with which the reactions proceed in the presence of certain quantities of NaOH* , in opposition to the theory, given by EISENBERG & VOLK, and others, that it is due to the conversion of agglutinine into agglutinoid. For it was invariably the case, that if the observations of the agglutination were made after the tubes had stood for $1\frac{1}{2}$ to 2 hours at 37° , the loss in agglutinating power exhibited by the serum was much greater than it proved to be if the measurements were deferred until the tubes had stood for a further 18 hours at the temperature of the room.

Tables I—XXXII.

The meanings of the abbreviations and of the figures given in the Tables are as follows:

A. A. the Absolute Amount of the immune-serum, measured in c.cm., needed to produce a degree of agglutination equal to that present in the test-tube selected as standard.

R. A. the Relative Amount of the immune-serum necessary to produce the given degree of agglutination. The actual amount of the serum which is taken as equal to unity here is given, in c.cm., beneath the letters themselves.

The sign $>$ placed in front of a set of figures in the Tables indicates that this amount of agglutinating immune-serum produces either no agglutination or an agglutination less than that present in the test-tube selected as standard.

The sign $<$ placed in front of a set of figures in the Tables indicates that this amount of agglutinating immune-serum produces a stronger agglutination than that present in the test-tube selected as standard.

When two sets of figures are put together in a column in place of the usual single figure, as occurs for the first time in Table II, Series 8, in the case of the emulsion heated up to 90°, this implies that such a set of tubes began at some point in a "zone of inhibited agglutination". The effect of this is, that there are two tubes lower down in the set shewing a degree of agglutination equal to that seen in the tube selected as standard, MADSEN's method of measurement being employed.

When three sets of figures are given together in a column, the sign $>$ or $<$ will always be found in front of, at least, one set.

The three sets of figures similarly imply that a "zone of inhibited agglutination" occurred; but in these cases it was preceded by tubes either shewing or not shewing agglutination, and followed by tubes shewing agglutination.

In such cases, therefore, a standard degree of agglutination occurs twice (or sometimes three times) on passing down the set of tubes.

Table I.

	Series 1		Series 2		Series 3		Series 4		Series 5	
	B. coli agar suspension		B. typhosus agar suspension		B. coli bouillon culture		B. coli bouillon culture		B. coli bouillon culture	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0018=1)	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.0017=1)	A. A. c.cm.	R. A. (0.0013=1)
Culture: 24 Hours.	0.0004	1.0	0.0018	1.0	0.0003	1.0	0.0017	1.0	0.0013	1.0
— 3 Days..	0.0004	1.0	0.002	1.1	0.00087	2.9	0.0078	4.59	...	...
— 5 — ..	0.00045	1.13	0.0022	1.22	0.0012	4.0	0.0098	5.76	...	...
— 12 — ..	0.00038	0.95	0.0018	1.0	0.0048	16.0	0.03	17.6	0.038	29.2
— 19 — ..	0.00046	1.15	0.0018	1.0	0.0048	16.0	0.036	21.2	...	...
— 52 — ..	0.00045	1.13	0.002	1.1	...	...	...	...	...	...
— 62 — ..	0.00048	1.2	0.0025	1.39	...	...	...	...	...	...

Table II.

	Series 6		Series 7		Series 8		Series 9		Series 10	
	24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.00025=1)	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.0004=1)
Culture: unheated...	0.0004	1.0	0.00025	1.0	0.0004	1.0	0.0003	1.0	0.0004	1.0
— heated to 40°	0.0005	1.25	0.00028	1.12	0.00052	1.3	0.00028	0.93	0.0004	1.0
— — 50°	0.0005	1.25	0.00038	1.52	0.00048	1.2	0.0004	1.33	0.0004	1.0
— — 60°	0.0007	1.75	0.0005	2.0	0.00058	1.45	0.00048	1.6	0.00055	1.38
— — 70°	0.0009	2.25	0.0007	2.8	0.00065	1.63	0.00055	1.83	0.00065	1.63
— — 75°	...	...	...	...	...	...	...	...	0.0025	6.25
— — 80°	0.018	45.0	0.0025	10.0	0.0058	14.5	0.0048	16.0	0.005	12.5
— — 90°	>0.02	>50.0	0.003	12.0	>0.01*) 0.0075	>25.0 18.75	>0.01	>33.3	0.05 0.0115	125.0 28.75
— — 100°	>0.02	>50.0	0.0035	14.0	0.007	17.5	>0.01	>33.3	0.007 0.0115	17.5 28.75

*) See the explanation preceeding Table I.

Table III.

	Series 11		Series 12		Series 13		Series 14		Series 15	
	24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension	
	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.0002=1)	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.0002=1)	A. A. c.cm.	R. A. (0.0003=1)
Culture: unheated ...	0.0003	1.0	0.0002	1.0	0.0003	1.0	0.0002	1.0	0.0003	1.0
— heated to 40°	0.00028	0.93	0.0002	1.0	0.00028	0.93	0.0002	1.0	0.00035	1.17
— — - 50°	0.0003	1.0	0.0002	1.0	0.00038	1.27	0.00025	1.25	0.0003	1.0
— — - 60°	0.0004	1.33	0.00045 0.00075	2.25 3.75	0.00058	1.93	0.0008 0.00038	4.0 1.9	0.00035	1.17
— — - 70°	0.00052	1.73	0.0009	4.5	0.00075 0.0015	2.5 5.0	0.0012 0.00045	6.0 2.25	0.0005	1.67
— — - 75°	0.00085 0.0017	2.83 5.67	0.00095	4.75	0.0065 0.0025	8.3	0.0014	7.0	0.00075	2.5
— — - 80°	0.0022	7.3	0.0028 0.0012	14.0 21.0	0.01 0.0032	33.0 10.7	0.0028	14.0	0.0028	9.33
— — - 90°	0.006 0.0028	20.0 9.3	0.0062	31.0	0.0152 0.0072	50.7 24.0	0.05 0.0032	25.0 16.0	0.003	10.0
— — - 100°	0.01 0.004	133.0 13.3	0.0028 0.006	14.0 30.0	0.026 0.0048	87.0 16.0	0.0022	11.0	0.0032	10.67

Table IV.

	Series 16		Series 17		Series 18		Series 19		Series 20	
	24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.00017=1)	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.00011=1)
Culture: unheated ...	0.0004	1.0	0.0004	1.0	0.00017	1.0	0.0003	1.0	0.00011	1.0
— heated to 40°	0.00035	0.86	0.00038	0.95	0.0002	1.18	0.00038	0.93	0.00012	1.09
— — - 50°	0.00035	0.86	0.0004	1.0	0.0003	1.76	0.00025	0.83	0.00012	1.09
— — - 60°	0.0005	1.25	0.00055	1.38	0.00055	3.24	0.0003	1.0	0.00015	1.27
— — - 70°	0.00058	1.45	0.00065	1.63	0.00065	3.82	0.00038	1.27	0.0002	1.82
— — - 75°	0.0009 0.00185	2.25 4.63	0.0095 0.0025	23.75 6.25	...	...	...	...	0.00065	5.9
— — - 80°	0.003	7.5	0.003	7.5	0.0015	26.5	0.002	6.67	0.001	9.09
— — - 90°	0.0038	9.5	>0.01 0.0045	>25.0 11.25	0.006	35.3	0.0025	8.33	0.0009	8.2
— — - 100°	0.0025	6.25	0.01 0.0015	25.0 11.25	0.006	35.3	0.0025	8.33	0.0012	10.9

Table V.

	Series 21		Series 22		Series 23		Series 24		Series 25	
	36 Hours B. coli agar suspension		48 Hours B. coli agar suspension		4 Days B. coli agar suspension		50 Days B. coli agar suspension		50 Days B. coli agar suspension	
	A. A. c.cm.	R. A. (0.0002=1)	A. A. c.cm.	R. A. (0.0008=1)	A. A. c.cm.	R. A. (0.00028=1)	A. A. c.cm.	R. A. (0.0007=1)	A. A. c.cm.	R. A. (0.00045=1)
Culture: unheated ...	0.0002	1.0	0.0008	1.0	0.00028	1.0	0.0007	1.0	0.00045	1.0
— heated to 40°	0.00022	1.1	0.00085	1.06	0.00028	1.0	0.00072	1.03	0.0005	1.11
— — - 50°	0.00035	1.75	0.0008	1.0	0.00028	1.0	0.0007	1.0	0.0005	1.11
— — - 60°	0.0005	2.5	0.00078	0.98	0.0004	1.43	0.00075	1.07	0.00055	1.22
— — - 70°	0.0008	4.0	0.0008	1.0	0.0005	1.79	0.0009	1.29	0.0006	1.33
— — - 75°	...	...	...	...	0.0006	2.14	...	...	...	...
— — - 80°	0.002	10.0	0.003	3.75	0.0025	8.93	0.0022	3.14	0.001	2.22
— — - 90°	0.0038	19.0	0.003	3.75	0.0025	8.93	0.0025	3.57	0.0012	2.67
— — -100°	0.004	20.0	0.032 0.0072	40.0 9.0	0.0026	9.29	0.0025	3.57	0.0012	2.67

Table VI.

	Series 26		Series 27		Series 28		Series 29	
	52 Days B. coli agar suspension		55 Days B. coli agar suspension		24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.00005=1)	A. A. c.cm.	R. A. (0.00085=1)
Culture: unheated ...	0.0004	1.0	0.0004	1.0	0.00065	1.0	0.00085	1.0
— heated to 40°	...	...	0.00038	0.95	0.0006	0.92	0.00085	1.0
— — - 50°	0.00045	1.13	0.0004	1.0	0.00085	1.3	0.0011	1.29
— — - 60°	...	...	0.00038	0.95	0.0015	2.3	0.0016	1.88
— — - 70°	0.00055	1.38	0.0005	1.25	0.0016	2.5	0.006	7.1
— — - 75°	...	...	...	...	...	...	...	...
— — - 80°	0.0022	5.5	0.0018	4.5	0.012	18.4	0.0112	13.2
— — - 90°	0.0022	5.5	0.002	5.0	0.014	21.5	0.022	25.9
— — -100°	0.0025	6.25	0.002	5.0	0.016	24.6	0.036	42.4

Table VII.

	Series 30		Series 31		Series 32	
	24 Hours		24 Hours		62 Days	
	B. typhosus agar suspension		B. typhosus agar suspension		B. typhosus agar suspension	
	A. A. c.cm.	R. A. (0.00035 = 1)	A. A. c.cm.	R. A. (0.0008 = 1)	A. A. c.cm.	R. A. (0.0018 = 1)
Culture: unheated	0.00035	1.0	0.0008	1.0	0.0018	1.0
— heated to 40°	0.00035	1.0	0.0009	1.13	0.0019	1.06
— — 50°	0.0001	1.14	0.001	1.25	0.0018	1.0
— — 60°	0.0008	2.3	0.0022	2.75	0.002	1.11
— — 70°	0.0002	5.7	0.005	6.25	0.003	1.67
— — 75°	...	...	...	...	...	...
— — 80°	0.006	17.1	0.005	6.25	0.005	2.78
— — 90°	0.016	45.7	0.015	18.75	0.005	2.78
— — 100°	0.016	45.7	0.018	22.5	0.0055	3.06

Table VIII.

	Series 33		Series 34		Series 35		Series 36		Series 37	
	24 Hours		24 Hours		24 Hours		24 Hours		24 Hours	
	B. coli agar suspension		B. coli agar suspension		B. coli agar suspension		B. coli agar suspension		B. coli agar suspension	
	A. A. c.cm.	R. A. (0.001=1)	A. A. c.cm.	R. A. (0.001=1)	A. A. c.cm.	R. A. (0.0009=1)	A. A. c.cm.	R. A. (0.0009=1)	A. A. c.cm.	R. A. (0.00085=1)
Culture: unheated	0.001	1.0	0.001	1.0	0.0009	1.0	0.0009	1.0	0.00085	1.0
— heated to 70°: 1 min.	0.005	5.0	0.0071	7.4	0.0074	8.2	0.006	6.67	0.007	8.2
— — 3 —	0.005	5.0	0.0076	7.6	0.007	7.8	0.01	11.1	0.008	9.4
— — 10 —	0.01	10.0	0.04	40.0	0.032	35.6	0.01 <0.001	11.1 <1.1	0.007	8.2
— — 22 —	0.011	11.0	>0.04	>40.0	0.064	71.1	0.009*) 0.005 <0.001	10.0 5.5 1.1	0.013	15.3
— — 33 —	0.012	12.0	>0.04		0.09 <0.001	100.0 <1.1	0.01 0.005 <0.001	11.1 5.5 <1.1	0.009	10.6
— — 75 —	0.015	15.0	>0.04		0.09 <0.001	100.0 <1.1	0.009 <0.001	10.0 <1.1	0.007	8.2

*) See the explanation preceding Table I.

Table IX.

	Series 38		Series 39		Series 40		Series 41		Series 42	
	24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture	
	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.
	c.cm.	(0.001=1)	c.cm.	(0.00085=1)	c.cm.	(0.001=1)	c.cm.	(0.00085=1)	c.cm.	(0.00065=1)
Culture: unheated	0.001	1.0	0.00085	1.0	0.001	1.0	0.00085	1.0	0.00065	1.0
— heated to 70°: 1 min.	0.0023	2.3	0.004	4.7	0.0016	1.6	0.0074	8.7	0.0031	5.23
— — — — 3 —	0.0022	2.2	0.008	9.4	0.007	7.0	0.007	8.2	0.008	12.3
— — — — 10 —	0.0024	2.4	0.0075	8.8	0.007	7.0	0.0074	8.7	0.007	10.8
— — — — 22 —	0.0022	2.2	0.008	9.4	0.0075	7.5	0.0076	8.9	0.007	10.8
— — — — 33 —	0.0019	1.9	0.0075	8.8	0.008	8.0	0.0068	8.0	0.007	10.8
— — — — 75 —	0.0022	2.2	0.008	9.4	0.01	10.0	0.007	8.2	0.0081	12.9

Table X.

	Series 43		Series 44		Series 45		Series 46		Series 47	
	24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension	
	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.
	c.cm.	(0.0042=1)	c.cm.	(0.003=1)	c.cm.	(0.0022=1)	c.cm.	(0.0022=1)	c.cm.	(0.00025=1)
Culture: unheated	0.0042	1.0	0.003	1.0	0.0022	1.0	0.0022	1.0	0.00025	1.0
— heated to 100°: 1 min.	>0.05	>11.9	0.08	26.7	0.01	4.5	0.008	3.67	0.0035	14.0
— — — — 1 hour	...	...	...	...	...	...	...	...	0.005	20.0
— — — — 2 —	0.0048	1.14	0.01	3.3	0.0015	0.68	0.0007	0.32	0.0017	6.8
— — — — 3 —	...	...	...	...	...	...	...	...	0.001	4.0
— — — — 5 —	...	...	...	...	...	...	0.0005	0.23	...	...

Table XI.

	Series 48		Series 49		Series 50		Series 51		Series 52	
	24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli agar suspension		24 Hours B. coli bouillon culture		24 Hours B. coli bouillon culture + 1% Formaldehyde	
	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.	A. A.	R. A.
	c.cm.	(0.0002=1)	c.cm.	(0.0002=1)	c.cm.	(0.0003=1)	c.cm.	(0.00018=1)	c.cm.	(0.00028=1)
Culture: unheated	0.0002	1.0	0.0002	1.0	0.0003	1.0	0.00018	1.0	0.00028	1.0
— heated to 100°: 1 min.	...	...	...	...	0.0032	10.7	0.0012	6.7	0.0032	11.4
— — — — 1 hour	0.0045	22.5	0.0045	22.5	0.0035	11.7	0.0013	7.2	0.0019	6.8
— — — — 2 —	0.00185	9.25	0.003	15.0	0.0025	8.3	0.0013	7.2	0.0013	4.6
— — — — 3 —	0.0013	6.5	0.0025	12.5	...	...	0.0013	7.2	0.0013	4.6
— — — — 5 —	...	...	0.00185	9.25	...	...	...	...	...	...
— — — — 7 —	...	...	0.0013	6.5	...	...	...	...	...	...
— — — — 13 —	...	...	0.0008	4.0	...	...	...	...	...	...

Table XII.

	Series 53		Series 54		Series 55	
	B. coli agar suspension		B. coli agar suspension		B. coli agar suspension	
	A. A. c.cm.	R. A. (0.0003=1)	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0004=1)
Coli-serum (G 19) unheated	0.0003	1.0	0.0004	1.0	0.0004	1.0
— undiluted, heated to 60° 1/2 hr.	0.00032	1.07	...	...	...	...
— diluted 1:10, — - — —	0.00028	0.93	...	...	0.0004	1.0
— — 1:100, — - — —	0.00035	1.17	...	...	0.00038	0.95
— undiluted, heated to 65° 1/2 hr.	>1.0 0.0005 0.0003	>333.0 21.7 1.0	>1.0 0.0115 0.0006	>2500.0 28.75 1.5	...	...
— diluted 1:10, — - — —	0.00035	1.17	>0.1 0.05 0.00042	>250.0 125.0 1.05	>0.1 0.025 0.0005	>250.0 62.5 1.25
— — 1:100, — - — —	0.00032	1.07	0.0004	1.0	0.00045	1.13
— — 1:1000, — - — —	...	...	...	...	0.00042	1.05
— undiluted, heated to 70° 1/2 hr.	...	...	...	...	...	...
— diluted 1:10, — - — —	...	...	0.03	75.0	>0.1 0.04 0.025	>250.0 100.0 62.5
— — 1:100, — - — —	0.001	3.3	0.006	15.0	0.004	10.0
— — 1:1000, — - — —	...	...	...	...	>0.001	>2.5

Table XIII.

	Series 56		Series 57		Series 58	
	B. coli agar suspension		B. coli agar suspension		B. coli bouillon culture	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0001=1)	A. A. c.cm.	R. A. (0.0001=1)
Coli-serum (G 19) unheated	0.0004	1.0	0.0001	1.0	0.0001	1.0
— diluted 1:5, heated to 60° 1/2 hr.	0.0004	1.0	0.0001	1.0	...	...
— — 1:10, — - — —	0.0005	1.25	0.00013	1.3	...	...
— — 1:100, — - — —	0.00035	0.88	0.0001	1.0	...	...
— — 1:5, heated to 65° 1/2 hr.	>0.2 0.0045 0.0005	>500.0 11.25 1.25	>0.2 0.03 0.0002	>2000.0 300.0 2.0	...	...
— — 1:10, — - — —	>0.1 0.0075 0.00032	>250.0 18.75 0.8	0.00013	1.3	0.00013	1.3
— — 1:100, — - — —	0.00032	0.8	0.00012	1.2	0.00015	1.5
— — 1:1000, — - — —	...	...	...	...	0.00016	1.6
— — 1:5, heated to 70° 1/2 hr.	>0.2	>500.0	>0.2 0.045 0.005	>2000.0 450.0 50.0	...	...
— — 1:10, — - — —	>0.1 0.02	>250.0 50.0	>0.1 0.07 0.0052	>1000.0 700.0 52.0	...	...
— — 1:100, — - — —	>0.01 0.0035	25.0 8.75	0.0017	17.0	...	...

Table XIV.

	Series 59										Series 60					
	B. coli agar suspension, after										B. coli bouillon-culture, after					
	1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later						1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later	
	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.00019=1)	A. A. c.cm.	R. A. (0.00028=1)					A. A. c.cm.	R. A. (0.0007=1)	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0005=1)
Coli-serum (G 26) unheated	0.0004	1.0	0.00019	1.0	0.00028	1.0					0.0007	1.0	0.0004	1.0	0.0005	1.0
—	>0.1	>25.0	0.0035	87.5	0.00022	1.16					0.00085	1.21	0.0006	1.5	0.0007	1.4
—	0.00053	1.33	0.0004	1.0	0.00022	1.16					0.00096	1.37	0.00075	1.88	0.0009	1.8
—	>0.1	>25.0	0.001	5.26	0.00035	1.25					0.00085	1.21	0.00065	1.63	0.0006	1.2
—	>0.01	25.0	0.00095	5.0	0.0008	2.86					0.0025	3.57	0.0015	3.75	0.0017	3.4
—	0.002	5.0														

Table XV.

	Series 61										Series 62					
	B. coli agar suspension, after										B. coli bouillon-culture, after					
	1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later						1 1/4 hrs. at 37°		2 1/4 hrs. at 47°		18 hrs. later	
	A. A. c.cm.	R. A. (0.00035=1)	A. A. c.cm.	R. A. (0.00018=1)	A. A. c.cm.	R. A. (0.00028=1)					A. A. c.cm.	R. A. (0.00035=1)	A. A. c.cm.	R. A. (0.00018=1)	A. A. c.cm.	R. A. (0.00025=1)
Coli-serum (G 26) unheated	0.00035	1.0	0.00018	1.0	0.00028	1.0					0.00035	1.0	0.00018	1.0	0.00025	1.0
—	>0.1	>285.7	0.06	171.4	0.00018	1.0					0.0005	1.43	0.00025	1.39	0.00032	1.28
—	0.0004	1.14	0.00035	1.0	0.00032	1.14					0.00083	2.37	0.00025	1.39	0.0003	1.2
—	0.025	71.4	0.0013	7.22	0.00035	1.25					0.001	2.86	0.00065	3.41	0.0007	2.8
—	0.01	28.6	0.0009	5.0	0.0008	2.86										

Table XVII

	Series 65						Series 66					
	B. coli agar suspension, after						B. coli bouillon-culture, after					
	1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later		1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later	
	A. A. c.cm. (0.0004=1)	R. A. c.cm. (0.0004=1)	A. A. c.cm. (0.0002=1)	R. A. c.cm. (0.0002=1)	A. A. c.cm. (0.00015=1)	R. A. c.cm. (0.00015=1)	A. A. c.cm. (0.00035=1)	R. A. c.cm. (0.00035=1)	A. A. c.cm. (0.00017=1)	R. A. c.cm. (0.00017=1)	A. A. c.cm. (0.00017=1)	R. A. c.cm. (0.00017=1)
Coli-serum (G 50):												
unheated	0.0004	1.0	0.0002	1.0	0.00015	1.0	0.00035	1.0	0.00017	1.0	0.00017	1.0
diluted 1:10, heated to 70° 1 1/2 hr.	>0.1 0.009 0.00019	>250.0 22.5 0.48	>0.1 0.015 0.0012	>500.0 75.0 0.5	>0.1 0.018 0.0009	>666.7 120.0 0.6	>0.1 0.045 0.0008	>285.7 128.6 2.29	>0.1 0.085 0.00038	>588.2 500.0 2.24	>0.1 0.09 0.00033	>588.2 529.4 1.94
— 1:100, — — —	0.0015	3.75	0.00037	1.85	0.00032	2.13	0.002	5.71	0.00085	5.0	0.00065	3.82
— 1:1000, — — —	0.0009	2.25	0.00038	1.9	0.00032	2.13	>0.001	>2.86	0.00085	5.0	0.00065	3.82
— 1:10, heated to 70° 1 hr.	>0.1 0.009 0.00025	>250.0 22.5 0.63	>0.1 0.009 0.00012	>500.0 45.0 0.5	>0.1 0.012 0.00009	>666.7 80.0 0.6	>0.1 0.075 0.0012	>285.7 214.3 3.43	>0.1 0.09 0.00033	>588.2 529.4 1.94	0.00032	1.88
— 1:100, — — —	0.0022	5.5	0.00038	1.9	0.00032	2.13	0.0022	6.29	0.00092	5.41	0.00085	5.0
— 1:1000, — — —	>0.001	>2.5	0.00038	1.9	0.00032	2.13	>0.001	>2.86	0.00092	5.41	0.00083	4.88
— 1:10, heated to 70° 2 hr.	>0.1 0.09 0.00036	>250.0 22.5 0.9	>0.1 0.009 0.00018	>500.0 45.0 0.9	>0.1 0.011 0.00012	>666.7 73.3 0.8	0.1 0.0012	285.7 3.43	0.0006	3.53	0.0006	3.53
— 1:100, — — —	>0.01	>25.0	0.00065	3.25	0.00033	2.2	0.0033	9.43	0.0017	10.0	0.0016	9.41
— 1:1000, — — —	0.001	2.5	0.00048	2.4	0.00032	2.13	>0.001	>2.86	>0.001	>5.9	0.0017	10.0

Table XVIII.

		Series 67					
		B. coli agar suspension, after					
		1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later	
		A. A. c.cm.	R. A. (0.00016=1)	A. A. c.cm.	R. A. (0.00012=1)	A. A. c.cm.	R. A. (0.00011=1)
Coli-serum (G 50):							
diluted with normal saline, unheated		0.00016	1.0	0.00012	1.0	0.00011	1.0
1:10, with normal saline, heated to 70° 1 hr.		>0.1 0.015 0.00012	>625.0 93.8 0.75	>0.1 0.018 0.00006	>833.3 150.0 0.5	>0.1 0.023 0.000054	>909.1 209.1 0.49
— 1:100, — — — — —		0.00033	2.06	0.00016	1.33	0.00014	1.27
— 1:1000, — — — — —		0.00057	3.56	0.00029	2.42	0.00026	2.36
— with 10% normal horse-serum, unheated .		0.00011	0.69	0.00008	0.67	0.00007	0.64
— 1:10, — — — heated to 70° 1 hr.		>0.1 0.007 0.00015	>625.0 41.3 0.94	>0.1 0.0085 0.000075	>833.3 70.8 0.63	>0.1 0.01 ...	>909.1 90.9 ...
— 1:100, — — — — —		0.00185	11.56	0.0009	7.5	0.00023	2.09
— 1:1000, — — — — —		0.0014	8.75	0.00075	6.25	0.00032	2.91

		Series 68					
		B. coli bouillon-culture, after					
		1 1/4 hrs. at 37°		2 1/4 hrs. at 37°		18 hrs. later	
		A. A. c.cm.	R. A. (0.00022=1)	A. A. c.cm.	R. A. (0.00014=1)	A. A. c.cm.	R. A. (0.00014=1)
Coli-serum (G 50):							
diluted with normal saline, unheated		0.00022	1.0	0.00014	1.0	0.00014	1.0
1:10, with normal saline, heated to 70° 1 hr.		0.0004	1.82	0.00024	1.71	0.00023	1.64
1:100, — — — — —		0.0009	4.09	0.00055	3.93	0.00054	3.86
— 1:1000, — — — — —		>0.001	>4.55	>0.001	>7.14	0.0011	7.86
— with 10% normal horse-serum, unheated .		0.00025	1.14	0.00013	0.93	0.00011	0.79
— 1:10, — — — heated to 70° 1 hr.		>0.1 0.022 0.0012	>154.5 100.0 5.45	>0.1 0.037 0.00033	>714.3 264.3 2.36	>0.1 0.045 0.00027	>714.3 321.4 1.93
— 1:100, — — — — —		>0.01	>45.5	0.0012	8.57	0.0011	7.86
— 1:1000, — — — — —		>0.001	>4.55	>0.001	>4.55	0.0015	10.71

Table XXIV.

Series 78							
B. coli agar suspension in normal saline							
A. alone		B. + 1 % normal horse-serum		C. + 0.1 % normal horse-serum		D. + 0.01 % normal horse-serum	
HCl in milligrams	Degree of agglutination (S.=standard)	HCl in milligrams	Degree of agglutination (S. = standard)	HCl in milligrams	Degree of agglutination (S. = standard)	HCl in milligrams	Degree of agglutination (S.=standard)
3.65 — 0.73	0 or < S	3.65 — 0.4745	0	3.65 — 0.4745	0	3.65 — 2.19	= or < S
0.6205—0.0621	> or = S	0.365—0.1095	> or = S	0.365 — 0.073	> or = S	1.825 — 0.1745	0
0.04745	0	0.09125	0	0.06205	0	0.365 — 0.06205	> or = S
						0.01745	0

Table XXV.

				Series 79			Series 80		
				B. coli bouillon culture			B. coli bouillon culture		
				A. A. c.cm.	R. A. (0.0004=1)	HCl in milli- grams	A. A. c cm.	R. A. (0.0005=1)	HCl in milli- grams
B. coli-serum (G 26) diluted 1:100, without HCl.....				0.0004	1.0	...	0.0005	1.0	...
— — — + 0.077 HCl per mille...				0.0005	1.25	0.0039	0.0005	1.0	0.00385
— — — 0.119 — — ...				0.0009	2.28	0.0107	...	...	...
— — — 0.186 — — ...				0.0013	3.25	0.0242	0.00095	1.9	0.01767
— — — 0.294 — — ...				0.0018	4.5	0.0529	...	...	...
— — — 0.408 — — ...				0.002	5.0	0.0816	0.0025	5.0	0.1020
— — — 0.611 — — ...				0.0027	6.75	0.1731	...	...	...
— — — 1.0 — — ...				0.0055	13.75	0.55	0.006	12.0	0.6
— — — 1.558 — — ...				...	...	...	0.0085	17.0	1.326
— — — 2.439 — — ...				...	...	...	0.0095	19.0	2.3181

Table XXVI.

						Series 81			Series 82		
						B. coli agar suspension			B. coli agar suspension		
						A. A. c.cm.	R. A. (0.0004=1)	HCl in milli- grams	A. A. c.cm.	R. A. (0.0008=1)	HCl in milligrams
Coli-serum (G 26) diluted 1:100, without HCl						0.0004	1.0	...	0.0008	1.0	...
—	—	—	—	+ 0.005 HCl per mille		0.0004	1.0	0.0002	...	...	...
—	—	—	—	+ 0.0067	—	0.0004	1.0	0.00027	...	...	...
—	—	—	—	+ 0.01	—	0.00032	0.8	0.00032	...	...	...
—	—	—	—			0.000185	0.46	0.00019	...	...	...
—	—	—	—	+ 0.013	—	0.00032	0.8	0.00042	...	...	...
—	—	—	—			0.0001	0.25	0.00013	...	...	...
—	—	—	—	+ 0.02	—	0.0004	1.0	0.0008	...	...	...
—	—	—	—			0.000115	0.29	0.00023	...	...	...
—	—	—	—	+ 0.025	—	0.00035	0.88	0.00088	...	...	...
—	—	—	—	+ 0.039	—	0.00035	0.88	0.00137	...	...	...
—	—	—	—	+ 0.049	—	0.00032	0.8	0.00157	...	...	...
—	—	—	—	+ 0.077	—	0.00022	0.55	0.00169	0.00095	1.19	0.00732
—	—	—	—	+ 0.095	—	0.00032	0.8	0.00304	0.00115	1.44	0.01093
—	—	—	—	+ 0.119	—	...	...	...	0.00115	1.44	0.01368
—	—	—	—	+ 0.149	—	0.0004	1.0	0.00596	0.0012	1.5	0.01788
—	—	—	—	+ 0.186	—	0.0005	1.25	0.0093	0.00115	1.44	0.02139
—	—	—	—	+ 0.294	—	0.0009	2.25	0.02646	>0.01 0.007 0.00085	>12.5 8.75 1.06	>0.294 0.2058 0.02499
—	—	—	—	+ 0.408	—	>0.01 0.007 0.0007	>25.0 17.5 1.75	>0.408 0.2856 0.02856	>0.01 0.005 0.00055	>12.5 6.25 0.69	>0.408 0.2040 0.0221
—	—	—	—	+ 0.641	—	>0.01 0.001 0.00045	>25.0 10.0 1.13	>0.641 0.2461 0.0288	>0.01 0.003 0.00035	>12.5 3.75 0.44	>0.641 0.1823 0.0224
—	—	—	—	+ 1.0	—	>0.01 0.0022 0.00028	>25.0 5.5 0.7	>1.0 0.22 0.028	>0.01 0.002 0.00025	>12.5 2.5 0.31	>1.0 0.2 0.025
—	—	—	—	+ 1.558	—	>0.01 0.0013 0.00017	>25.0 3.25 0.43	>1.558 0.2025 0.0265	...	...	...
—	—	—	—	+ 2.493	—	>0.01 0.00085 0.00012	>25.0 2.13 0.3	>2.493 0.2119 0.0299	...	...	...
—	—	Normal saline	+ 0.365	—	—	...	...	0.1460 0.026	...	...	0.1480 0.022

Table XXVII.

					Series 83				
					+ HCl			Neutralised	
					A. A. c.cm.	R. A. (0.0006 = 1)	HCl in milligrams	A. A. c.cm.	R. A. (0.0006 = 1)
B. coli-serum (G 26) diluted 1:100, without HCl					0.0006	1.0	...	0.0006	1.0
— — — — + 0.186 HCl per mille					0.00115 0.00035	1.92 0.58	0.0279 0.0065	0.00115	1.92
— — — — 0.408 — —					>0.01 0.005 0.00055	>16.67 8.33 0.92	>0.408 0.2040 0.0224	0.0016	2.67
— — — — 1.0 — —					>0.01 0.00185 0.00025	>16.67 3.08 0.42	>1.0 0.185 0.0250	0.0017	2.83
— — Normal saline 0.365 — —					...	...	0.4420 0.0219	...	...

Table XXVIII.

					Series 84					Series 85				
					B. coli agar suspension					B. coli bouillon culture				
					+ HCl			Neutralised		+ HCl			Neutralised	
					A. A. c.cm.	R. A. (0.0004=1)	HCl in milligr.	A. A. c.cm.	R. A. (0.0004=1)	A. A. c.cm.	R. A. (0.0002=1)	HCl in milligr.	A. A. c.cm.	R. A. (0.0002=1)
B. coli-serum (G 26) diluted:					0.0004	1.0	...	0.0004	1.0	0.0002	1.0	...	0.0002	1.0
1:100, without HCl					0.0006	1.5	0.01116	0.00055	1.38	0.0003	1.5	0.00558	0.0003	1.5
— + 0.186 HCl per mille					>0.01 0.0009 0.00018	>25.0 2.25 0.45	>1.558 0.1402 0.0280	0.0006	1.5	0.00075	3.75	0.1169	0.0005	2.5
— + 1.558 — —														
Normal saline							0.1460							
+ 0.365 — —					...	...	0.0256	...	...	...	...	...	...	...

Table XXIX.

					Series 86					Series 87				
					B. coli agar suspension					B. coli bouillon culture				
					+ HCl			Neutralised		+ HCl			Neutralised	
					A. A. c.cm.	R. A. (0.0005=1)	HCl in milligr.	A. A. c.cm.	R. A. (0.0005=1)	A. A. c.cm.	R. A. (0.0005=1)	HCl in milligr.	A. A. c.cm.	R. A. (0.0005=1)
G. coli-serum (G 26) diluted:					0.0005	1.0	...	0.0005	1.0	0.0005	1.0	...	0.0005	1.0
1:100, without HCl					>0.01	>20.0	>1.558	...	...	0.005	10.0	0.779	...	...
— + 1.558 HCl per mille														
— + 3.802 — —					>0.01	>20.0	>3.802	0.001 0.0008	2.0 1.6	0.0075	15.0	2.8515	0.0011 0.0011	2.2 2.2
— + 22.83 — —					>0.01	>20.0	>22.83	>0.01 0.0085	>20.0 17.0	>0.01 0.0025 0.0011	>20.0 5.0 2.2	>22.83 5.7075 2.5113	0.005 0.0027	10.0 5.4
Normal saline							0.1380							
+ 0.365 — —					...	...	0.0256	...	...	...	...	...	...	...

Table XXXII.

						Series 90		
						B. coli agar suspension		
						A. A. c.cm.	R. A. (0.0028 = 1)	HCl in milligrams
B. typhosus-serum (T 14) diluted 1:25, without HCl						0.0028	1.0	...
— — — — + 0.077 HCl per mille						0.003	1.1	0.00578
— — — — + 0.186 — —						>0.04 0.026 0.012	>14.3 9.29 4.29	>0.186 0.1209 0.0558
— — — — + 0.408 — —						>0.04 0.014 0.004	>14.3 5.0 1.13	>0.408 0.1428 0.0408
— — — — + 1.0 — —						>0.04 0.0071 0.00192	>14.3 2.61 0.69	>1.0 0.185 0.0408
— — — — + 1.558 — —						>0.04 0.0036 0.0014	>14.3 2.64 0.69	>1.558 0.1402 0.0545
— — — — + 3.802 — —						>0.04 0.00152 0.00068	>14.3 0.54 0.24	>3.802 0.1445 0.0646
— — — — + 9.167 — —						>0.04 0.00072 0.00044	>14.3 0.26 0.16	>9.167 0.1650 0.1008
— — — — + 22.83 — —						>0.04 <0.0004	>14.3 <0.143	>22.83 <0.2283
— — — — — —						...	...	...
— Normal saline + 0.365 — —						...	...	...

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OM CHINAALKALOIDERNE FORHOLD TIL CHLOR

AF

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KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1906

Angaaende Chlorets Indvirkning paa Chinaalkaloiderne er kun meget lidt bekendt.

Ved at lede Chlor i en saltsur Oplosning af Cinchoninchlorhydrat fik LAURENT i Aaret 1849¹⁾ udskilt et tungt, krystallinsk Bundfald, som han fandt at være Chlorhydratet af Cinchonindichlorid $C_{19}H_{20}Cl_2N_2O \cdot 2HCl$. — Selve Basen fremstillede han heraf ved Fældning med Ammoniak og ved Omkrystallisation af Vinaand, dens Chlorindhold bestemtes og passede med den antagne Formel.

Det salpetersure Salt var tungtopløseligt; det samme var Tilfældet med Bromhydratet og det ovenfor omtalte Chlorhydrat, hvilke begge vare isomorfe med Cinchonindichlorhydrat, $C_{19}H_{22}N_2O \cdot 2HCl$, Tavler med rhombisk Basis, hvis spidse Vinkler vare afstumpede. At det fundne Dichlorid er et Substitutionsprodukt anser LAURENT jo for en Selvfølge.

1892 gentog KOENIGS og COMSTOCK²⁾ Laurents Forsøg med Indvirkning af Chlor paa en saltsur Oplosning af Cinchonin. Det dannede Alkaloid blev rensed gennem Omkrystallisation af det tungtopløselige sure Nitrat. Alkaloidet havde ikke noget bestemt Smeltepunkt; ved langsom Ophedning smeltede det ved 202—204°, ved hurtig Ophedning mellem 220 og 230°, idet der indtraadte Sønderdeling. Rimeligvis har Forfatterne her havt at gjøre med en Blanding af 2 Alkaloider (α og β). Se senere. Ved Kogning med vinaandig Kali fraspaltedes Chlorbrinte ufuldstændigt og meget langsomt, hurtigere gik det ved Opvarmning med Amylalkohol og Kali. Det herved erholdte Produkt, der havde Smp. 203—204°, syntes da at være Dehydrocinchonin. Hermed var det i Virkeligheden vist, at Dichloridet ikke, som LAURENT mente, var et Substitutionsprodukt, men at Cinchoninet ligefrem ved Addition havde optaget de to Chloratomer. Paa dette Tidspunkt ere Forfatterne dog endnu ikke klare over dette Spørgsmaal, men henstille som uvist, om det omtalte Dichlorid er dannet ved Addition eller ved Substitution.

FILETI³⁾ opløste 15 Grm. Cinchonin i 4 Litr. stærkt fortyndet Saltsyre, mættede Oplosningen med Chlor og udsatte den for Sollyset. Herved dannedes lidt efter lidt en gul-hvid Udskilning, der dog sjældent var tydelig krystallinsk. Ved at hælde

¹⁾ Liebig's An. I, XIX. Pg. 8.

²⁾ Ber. d. deutsch. Chem. Ges. 25 (1892). Pg. 1545.

³⁾ ibid. 12. Pg. 423.